NOAA NESDIS Independent Review Team

Report –

Assessment Update One Year Later

November 8, 2013

Acknowledgements

- The following organizations continued to provide numerous briefings, detailed discussions and extensive background material to this Independent Review Team (IRT):
  - Department of Commerce (DOC)
  - National Oceanic and Atmospheric Administration (NOAA)
  - National Aeronautics and Space Administration (NASA)
  - Geostationary Operational Environmental Satellite R-Series (GOES-R) Program Office
  - Joint Polar Satellite System (JPSS) Program Office
  - NOAA/National Environmental Satellite, Data, and Information Service (NESDIS) IRT Liaison Support Staff:

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- This IRT is grateful for their quality support and commitment to the weather mission necessary for this assessment

Overview

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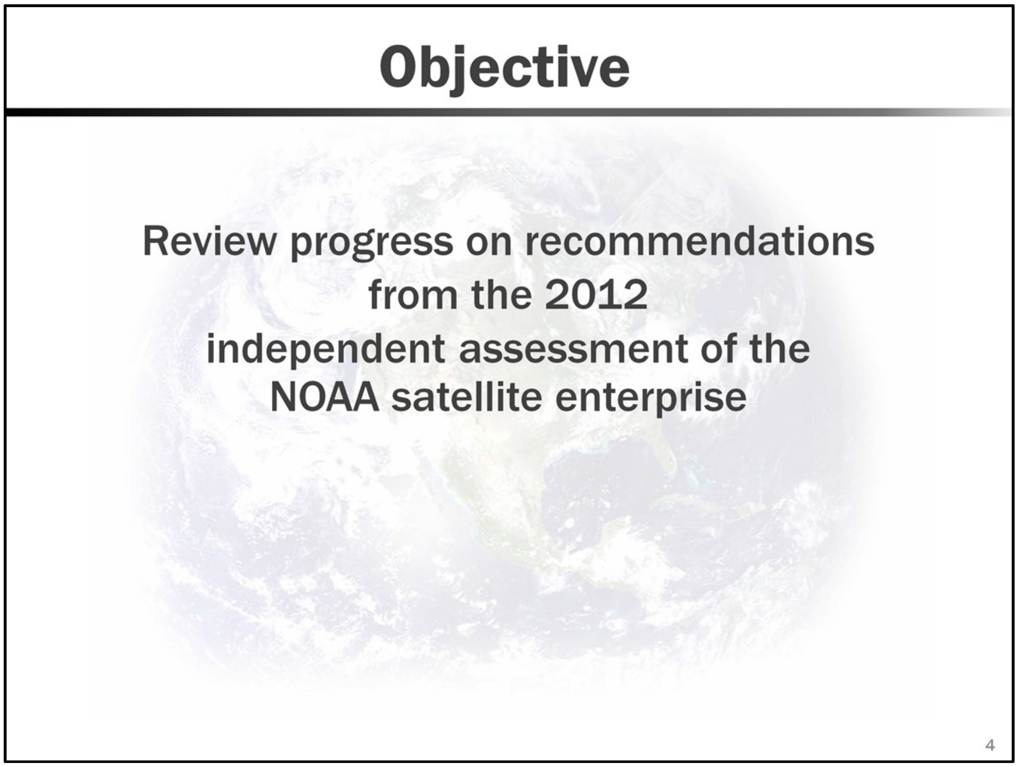
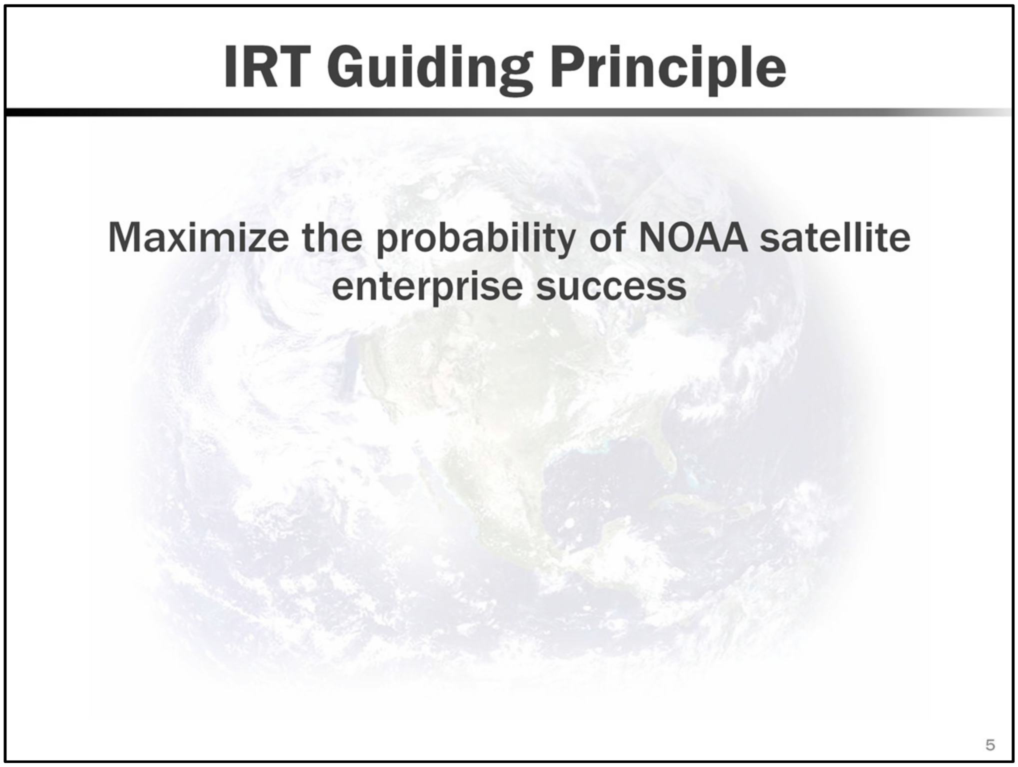
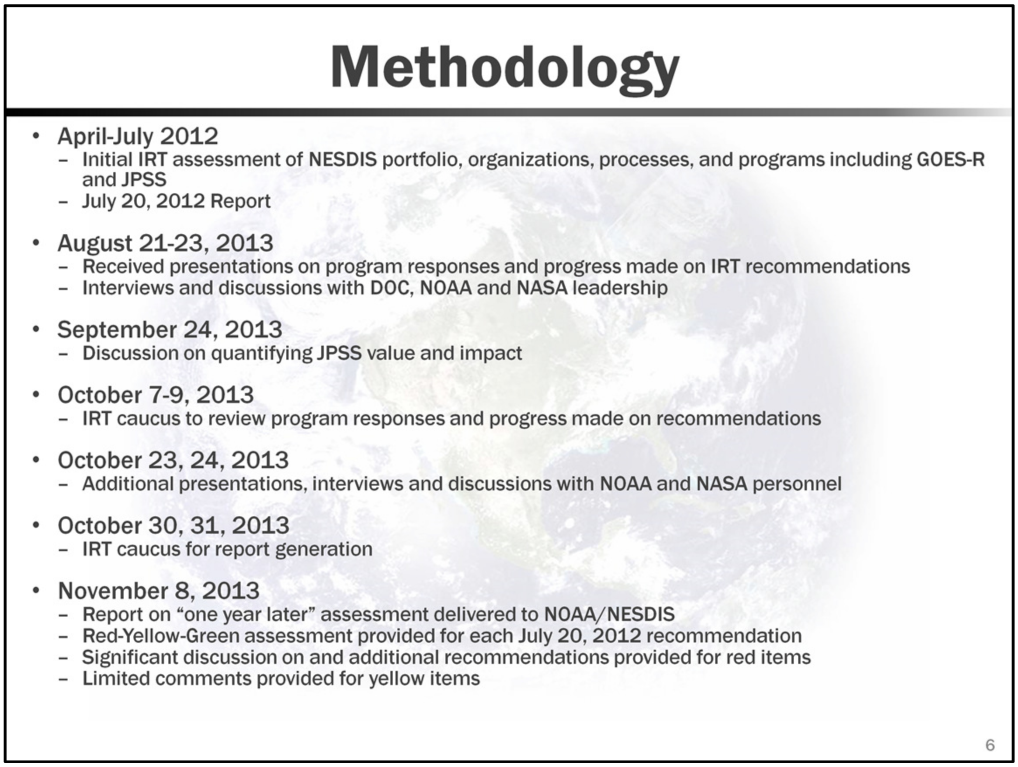
For the sources used in each figure see Appendix E.



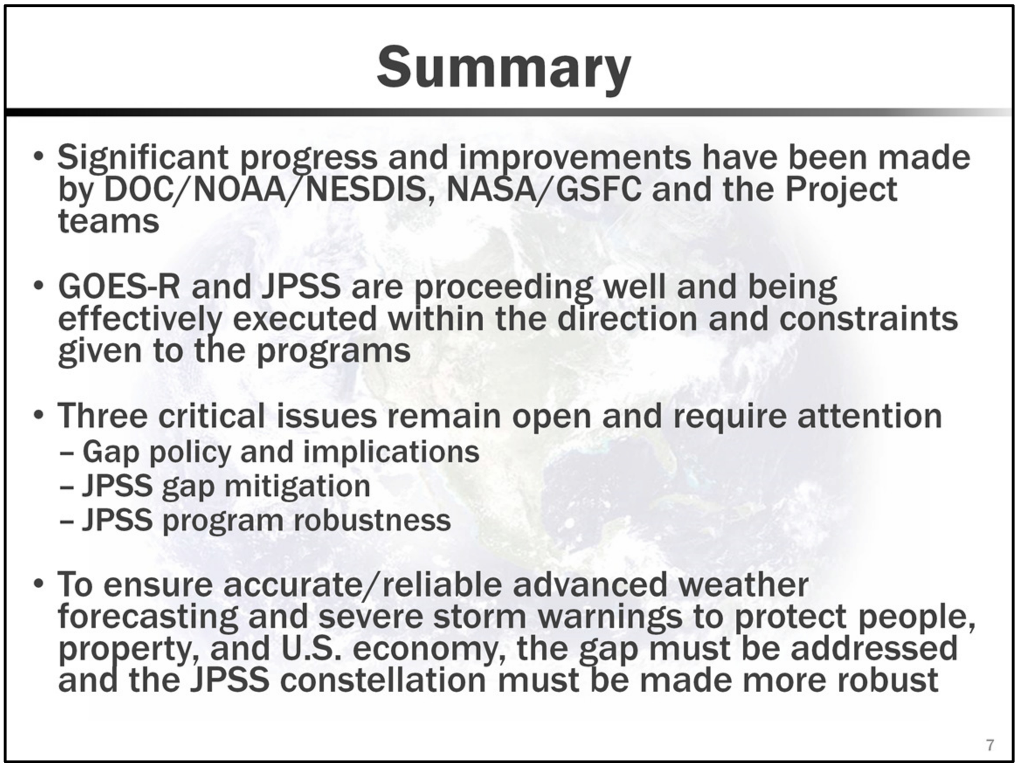
NOAA/NESDIS chartered the IRT to review the progress made from the independent assessment of the total NOAA satellite enterprise documented in the July 20, 2012 IRT Report. The scope of the assessment was from requirements to product delivery. The IRT assessment did not include an in-depth review of programs since such reviews are the responsibility of Standing Review Boards (SRBs). The SRB Chairs for Geostationary Operational Environmental Satellite – R Series (GOES-R) and Joint Polar Satellite System (JPSS) are members of the IRT. Their involvement facilitated the IRT's understanding of the status of these major programs. The purpose of the 2013 assessment was to evaluate the progress made in responding to the 2012 report.



The guiding principle used by the IRT in the conduct of the independent assessment and the development of recommendations was focused upon maximizing the probability of success of the NOAA satellite enterprise. Political and policy issues are clearly involved in such a major national undertaking. The IRT was not insensitive to these issues, however, the “success” criterion was the primary guiding principle.



The IRT was conducted from August through October 2013. Presentations were provided to the IRT that covered the NOAA satellite enterprise and non-attribution interviews were held with several key individuals involved in the NOAA satellite enterprise. The final element of the review was the development of the Findings and Recommendations. This element involved considerable discussion and debate within the IRT to ensure the integrated convictions of the team were incorporated in the results.



The IRT has completed an assessment of the response to the recommendations documented in the July 20, 2012 IRT report. Five areas of concern were discussed in that report. These concerns were the Oversight and Decision Process, Governance, JPSS Gap, Programs and Budget. While there were recommendations in each area of concern, the "Oversight and Decision Process" and the "JPSS Gap" dominated. The IRT viewed the "Oversight and Decision Process" as so dysfunctional and ineffective that failure to correct the deficiencies would greatly reduce the probability of success of the NOAA satellite program. These issues were largely internal to DOC/NOAA/NESDIS. The current assessment of the IRT is that these issues have been largely resolved.

GOES-R and JPSS are proceeding well and being effectively implemented within the direction and constraints given to the programs.

Critical issues that remain open and require urgent attention are:

- Gap Policy and Implications
- JPSS Gap Mitigation
- JPSS Program Robustness

Without accurate/reliable weather forecasting and severe storm warnings, lives, property and the U.S. economy are at risk. JPSS data are critical to the ability to provide these forecasts and warnings. There is currently an unacceptably high probability of a JPSS gap in observations, and there is not an adequate mitigation plan. The gap must be addressed with a gap mitigation plan and the establishment of a robust JPSS program. The IRT views this as a matter of critical national importance.

The current fragile, non-robust posture of the JPSS program is largely the result of external factors. Numerous decisions have been made that have had an adverse impact on JPSS. Some were decisions with good intentions but negative unintended consequences. The most adverse decision was in response to the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Nunn-McCurdy breach in 2006, which resulted in the elimination of multiple satellites. The proposed NPOESS program to respond to the breach set the stage for the fragile program that exists today. The subsequent decision by the Air Force to eliminate the Defense Weather Satellite System (DWSS) and early funding shortfalls for JPSS-1 further decreased the robustness.

Findings, Recommendations and Comments

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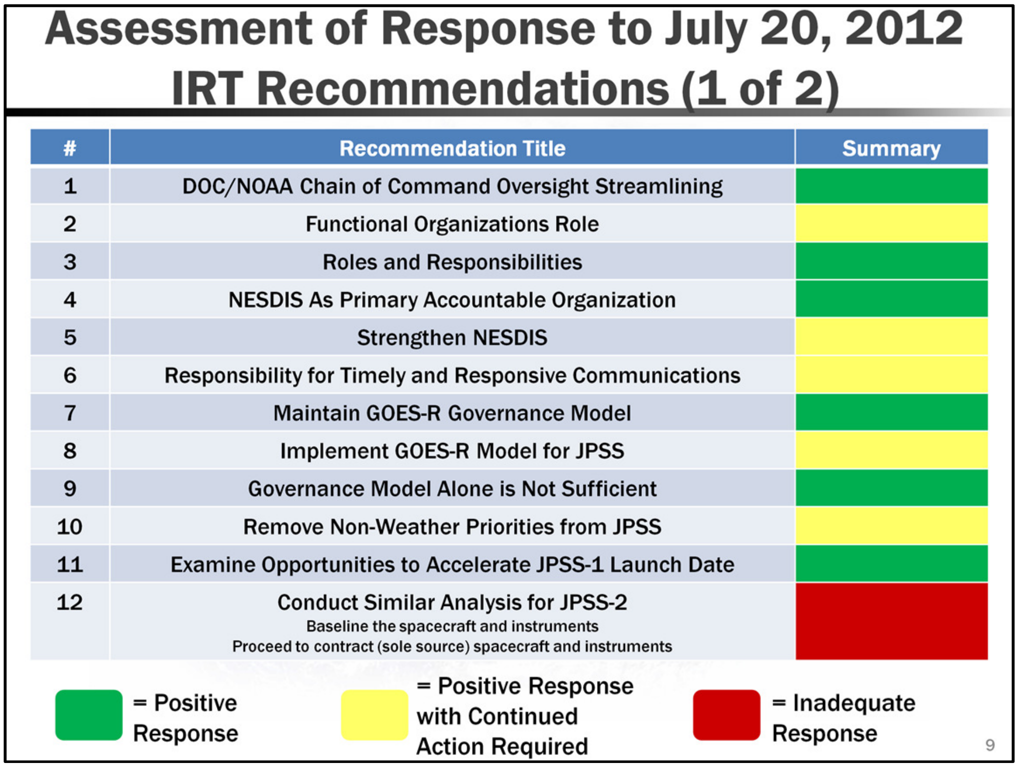


Assessment of Response to July 20, 2012 IRT Recommendations (1 of 2)

#	Recommendation Title	Summary
1	DOC/NOAA Chain of Command Oversight Streamlining	
2	Functional Organizations Role	
3	Roles and Responsibilities	
4	NESDIS As Primary Accountable Organization	
5	Strengthen NESDIS	
6	Responsibility for Timely and Responsive Communications	
7	Maintain GOES-R Governance Model	
8	Implement GOES-R Model for JPSS	
9	Governance Model Alone is Not Sufficient	
10	Remove Non-Weather Priorities from JPSS	
11	Examine Opportunities to Accelerate JPSS-1 Launch Date	
12	Conduct Similar Analysis for JPSS-2 Baseline the spacecraft and instruments Proceed to contract (sole source) spacecraft and instruments	

= Positive Response

= Positive Response with Continued Action Required

= Inadequate Response

9

The July 20, 2012 IRT report contained 23 recommendations. An assessment of the response to each recommendation has been made. A red-yellow-green approach has been used to communicate the results of the assessment. It is important to note that the definition of red-yellow-green is not the typical definition used in a risk analysis.

Green is used to convey that the response was assessed to be largely positive, however, additional actions may be required to completely address the issue. Yellow does not mean that it is almost red. Yellow means that the response is positive with continued planned action required. Red is used to indicate the response is inadequate.

13 areas were assessed as green and 7 were assessed yellow. The IRT believes this represents a positive response to the recommendations.

Three areas are assessed red or inadequate. The most significant are associated with the JPSS gap, the mitigation of the gap and the establishment of a robust program. The emphasis in this report is on these issues. There is also discussion of each yellow area and an additional red item.

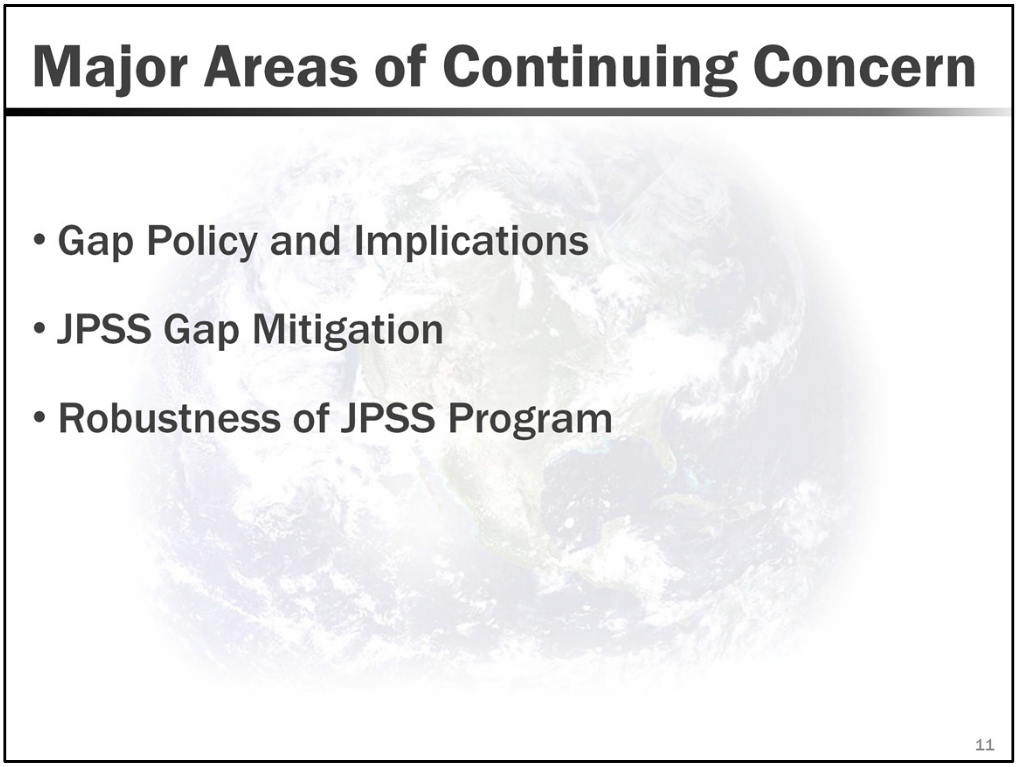
Assessment of Response to July 20, 2012 IRT Recommendations (2 of 2)

#	Recommendation Title	Summary
13	Implement Contingency Planning Given Possible Gap	
14	Establish Understanding of USAF Alternatives to DWSS	
15	GOES-R Schedule Requires Continued Vigilance	
16	JPSS Scope of Responsibilities	
17	IRT Supports Planned Transfer of OSVW to NASA	
18	Consider Jason-3 for Transfer to NASA	
19	COSMIC and DSCOVR Should Remain with NOAA	
20	JPSS Requirements Assessment	
21	Utilize more effectively the NCEP and JCSDA	
22	Complete JPSS ICE to Support FY14 Budget Submission	
23	Understand/Communicate why the Programs Cost So Much	

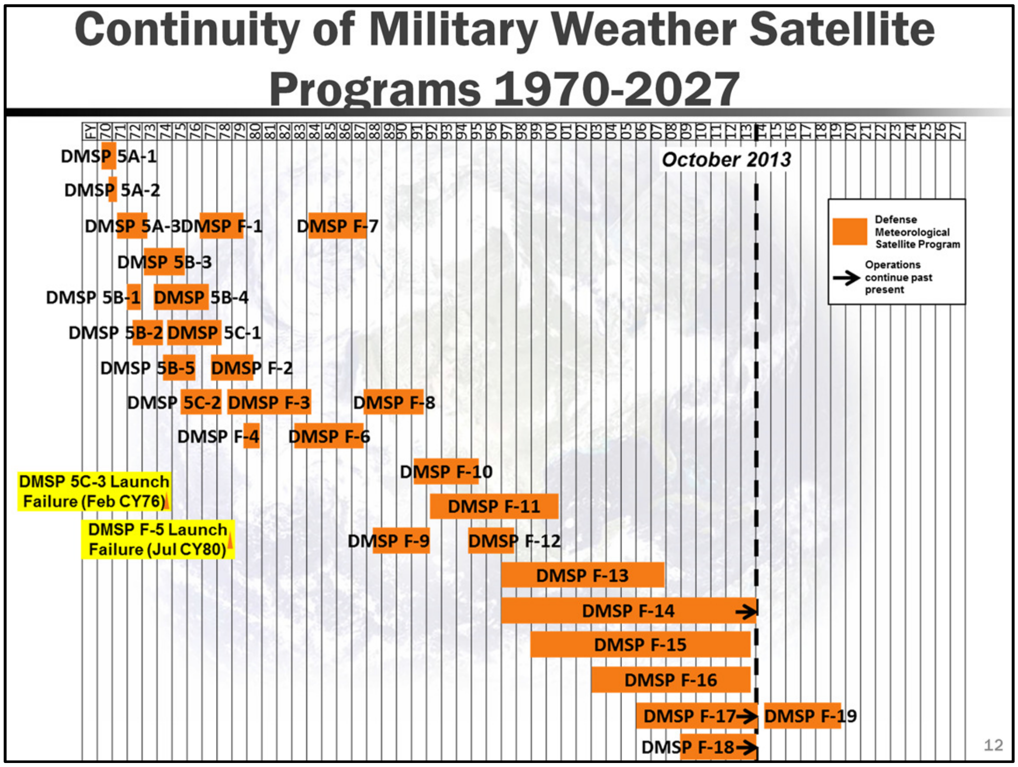
= Positive Response

= Positive Response with Continued Action Required

= Inadequate Response

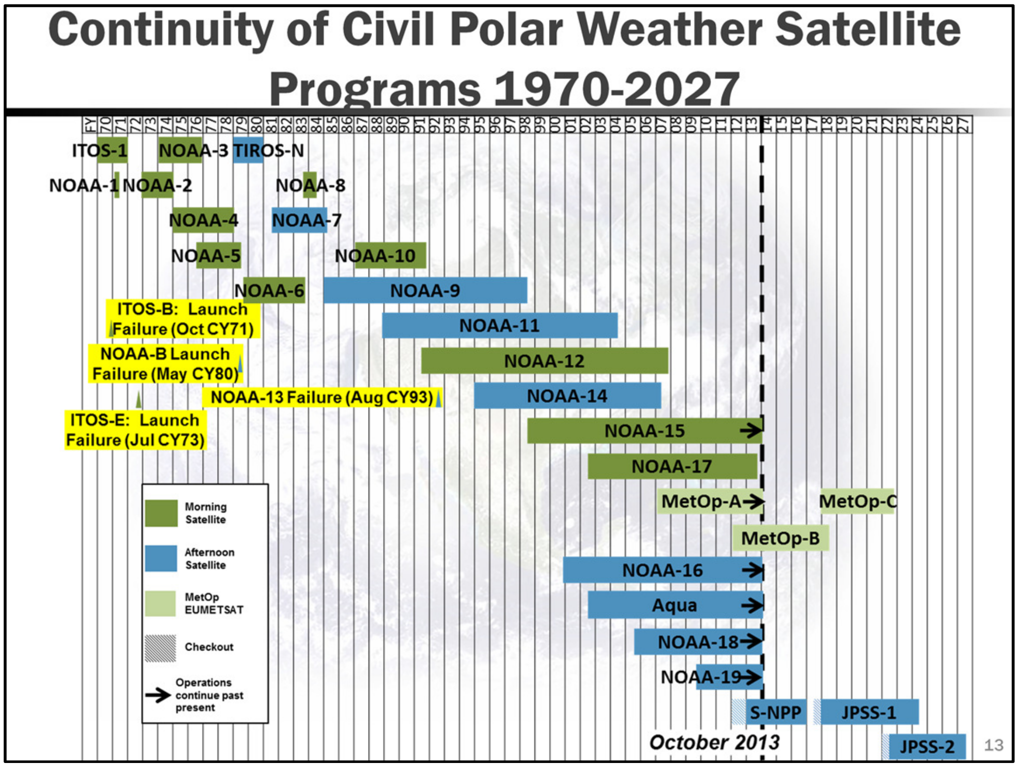


While much progress has been made in responding to last year's IRT report, the IRT believes that there are 3 remaining major areas of concern, each of which will be discussed further in the following charts. These 3 areas should be the primary focus of DOC/NOAA/NASA's attention after the release of this report. The ultimate objective is to establish a robust JPSS polar weather program consistent with other programs of critical national importance.



This chart depicts the historical robustness of the nation's military weather program, and is a backdrop for the remaining discussion. The Defense Meteorological Satellite Program (DMSP) satellites were built in blocks of satellites where major technology changes were incorporated periodically via block changes. In this way, several near-identical satellites could be built one after the other in a production line mode. This not only resulted in cost savings, but also created a robust program where the components and sub-systems of downstream satellites became the spares for the satellite getting ready to launch. Given this steady stream of satellites, whenever there was a launch vehicle or on-orbit failure, there was another DMSP satellite ready to launch on short notice. As can be seen above, this resulted in a very robust system, especially in the later years, typically with multiple satellites on-orbit at any given time. With 31 satellites developed in the series, these satellites were produced at an average rate of one satellite every 1.5 years. The Nation was well served by this approach.

No more DMSPs are being built (DMSPs 19 and 20 remain to be launched), and no follow-on military weather satellite program is currently approved. The Air Force is conducting an Analysis of Alternatives (AOA) to address the military's future weather satellite needs.

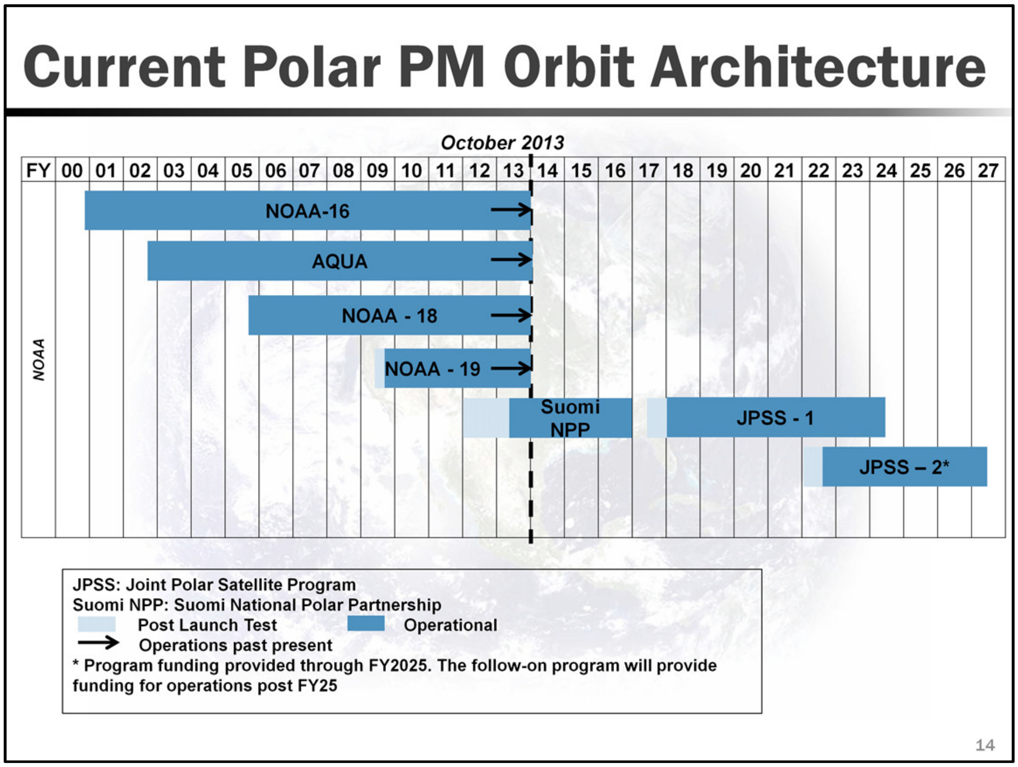


As in the case of the DMSP program described on chart 12, the Polar Operational Environmental Satellites (POES) satellites were built in blocks of satellites where major technology changes were incorporated periodically via block changes. In this way, several near-identical satellites could be built one after the other in a production line mode. This not only resulted in cost savings, but also created a robust program where the components and sub-systems of downstream satellites became the spares for the satellite getting ready to launch. Given this steady stream of satellites, whenever there was a launch vehicle or on-orbit failure, there was another POES satellite ready to launch on short notice. As can be seen above, this resulted in a very robust system, especially in the later years, typically with multiple satellites on-orbit at any given time. With 24 satellites developed in the series, these satellites were produced at an average rate of one satellite every 1.8 years. As in the case of the DMSP program, the Nation has greatly benefited from this approach.

This chart also shows the inclusion of NASA's Research and Development Aqua satellite which provides data from three advanced sensors: the Atmospheric Infrared Sounder (AIRS), the Advanced Microwave Sounding Unit (AMSU) and the Moderate Resolution Imaging Spectroradiometer (MODIS). These sensors are very important to improved weather forecasts.

Building upon NOAA's long-time cooperative relationship with the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), one response to the NPOESS Nunn-McCurdy breach in 2006 was to pass full responsibility to EUMETSAT's MetOp polar weather satellites for the mid-morning orbit. Thus, after Nunn-McCurdy, the NPOESS program was reduced to two polar orbits: early morning and early afternoon. In 2010, NPOESS was terminated, and the early morning orbit was assigned to the Air Force, which would cover that orbit initially through the DMSP satellites (Chart 12) and later through the DWSS program. NOAA would cover the early afternoon orbit with the JPSS program shown here by S-NPP, JPSS-1, and JPSS-2.

As noted elsewhere, the Air Force canceled DWSS in January of 2012.

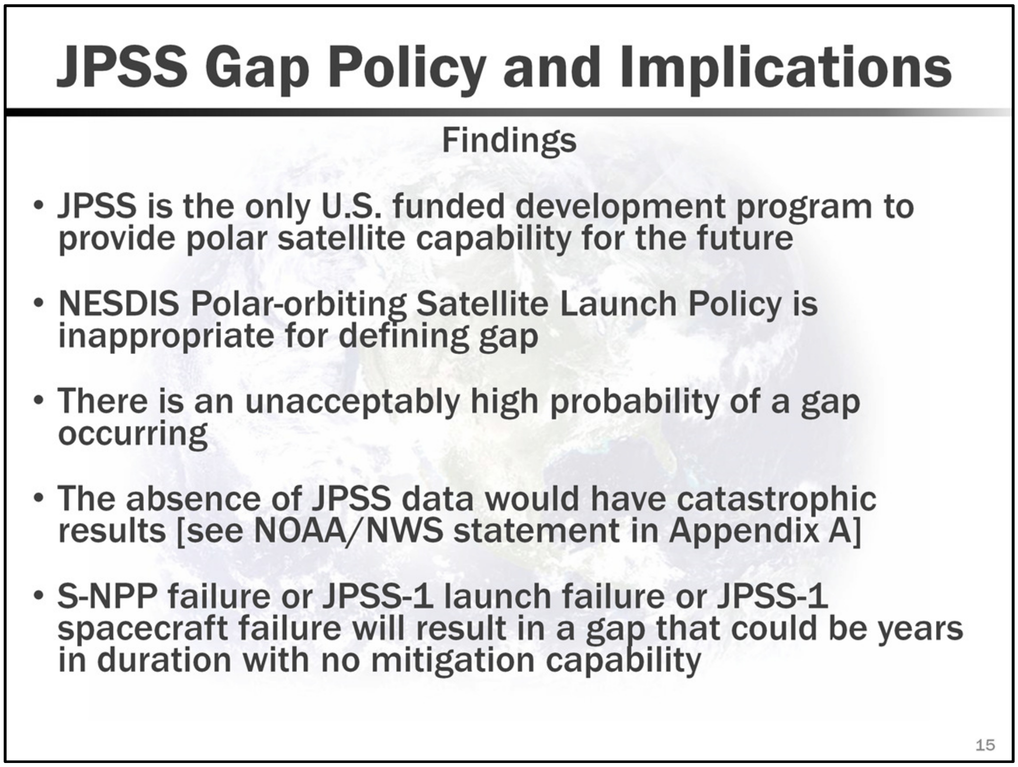


Extracting the more recent and planned NOAA polar orbiting weather satellites from chart 13, the above chart represents the Nation's current and planned civil weather satellite system. Currently, there exists a robust program relying upon multiple NOAA satellites and NASA's Aqua satellite, which are all operating beyond their design life. NOAA is currently relying on the S-NPP satellite for operational data, even though it was originally built as a Research and Development system, and as risk reduction for NPOESS.

However, the future polar program is demonstrably not robust. It is, in fact, quite subject to the creation of a gap in polar weather satellite coverage. In using the term "gap", the IRT means the possibility of having no U.S. satellite system available to provide polar weather data for the afternoon orbit.

The risk of a gap emerges toward the end of mission life of S-NPP, shown above at the end of FY16. By then, the legacy systems (NOAA-16, 18, 19 and Aqua) are well beyond mission design life if still functioning. Should S-NPP fail before JPSS-1 is launched and checked out, there will be a gap with no afternoon polar weather data available to the Nation.

The risk continues through the operational phase of JPSS-1. If JPSS-1 suffers a launch failure or premature spacecraft failure, then there will be a gap in afternoon polar satellite data until JPSS-2 is successfully launched and checked out. The gap risk re-emerges at the end of mission life of JPSS-2, because there is currently no follow-on program to JPSS-2. Should JPSS-2 end prematurely, the gap would be greatly magnified.

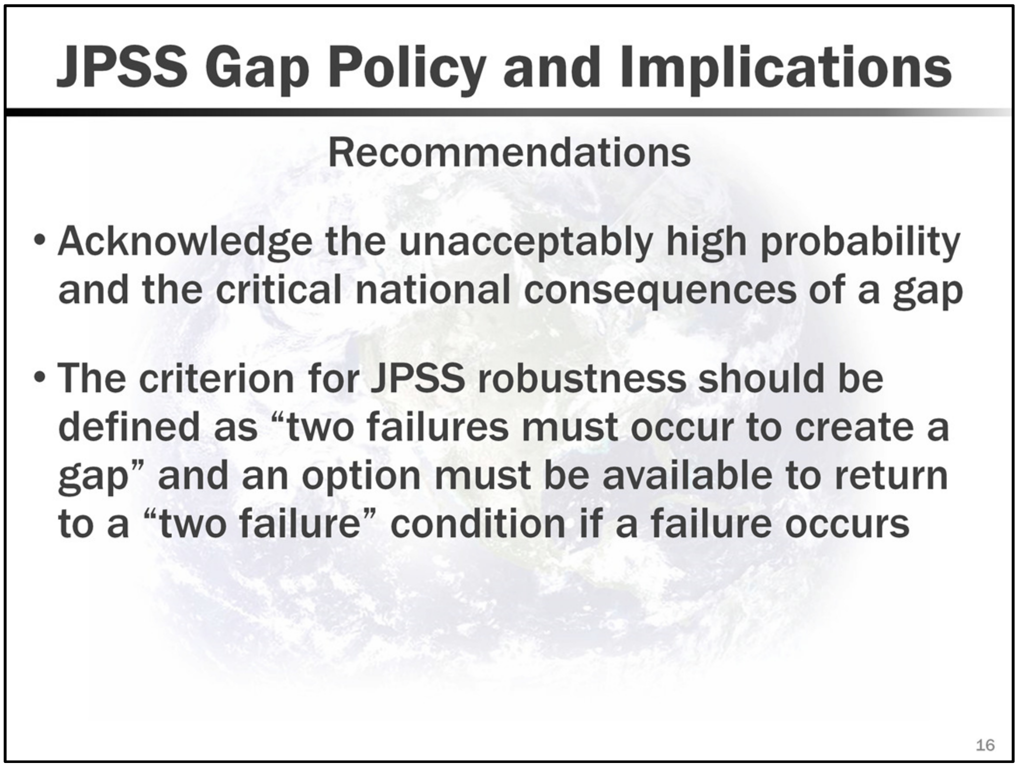


With the cancellation of NPOESS in 2010 and the subsequent cancellation of DoD's DWSS polar-orbiting weather satellite program, JPSS became the Nation's only polar weather satellite system currently in development. Given the uniqueness of JPSS, any gap in data availability becomes important.

The IRT believes the use of the NESDIS Polar-orbiting Satellite Launch Policy is inappropriate in defining the potential JPSS gap. Use of this policy promotes a misleading assessment of the likelihood and duration of the gap. Studies using this policy as a basis are flawed and should not be used. The IRT's conclusion is that there is an unacceptably high probability of a gap.

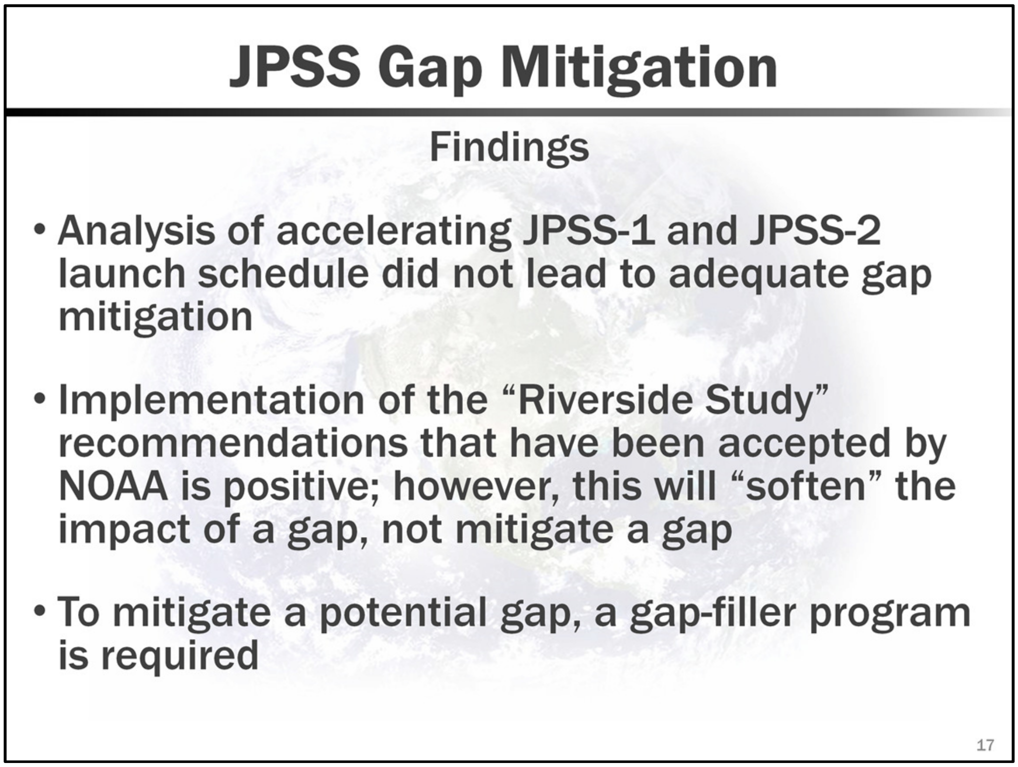
NOAA currently has a high quality weather forecasting capability that has become very much a part of the fabric of the U.S. society. It affects our safety, our quality of life and our economy. A gap in JPSS data will significantly degrade the current high quality forecasting capability upon which we have become dependent. Additionally, a gap can result in failure to accurately forecast severe weather events such as hurricanes, snowstorms/blizzards and tornadoes. In view of the above, the IRT believes that the absence of JPSS data due to a gap can have catastrophic national consequences.

The current JPSS program is a single string system. Any number of potential failures can result in a gap with a potential duration of months or years with no mitigation capability.



It is easy to become overly focused upon statistics and lose sight of the underlying non-robust architecture of JPSS. The IRT is convinced that there is an unacceptably high probability of a gap and this conclusion needs to be universally accepted to create the impetus for the necessary actions. A robust JPSS program is a necessary response to the gap concern.

The IRT believes that the definition of a robust program is that two failures must occur before a gap is created and an option must be available to return to a “two failure” condition if a failure occurs. This is how the POES and DMSP programs were designed, funded and operated. Decisions need to be made, resources dedicated and management actions implemented to quickly move the JPSS program in this direction.



In its 2012 study, the IRT requested that NOAA examine the possibility of accelerating both JPSS-1 and JPSS-2 to help with mitigating the gap in polar data. NOAA has concluded that the JPSS-1 schedule cannot be accelerated, and hence it cannot fill the early potential gap between end of life of S-NPP and launch and checkout of JPSS-1.

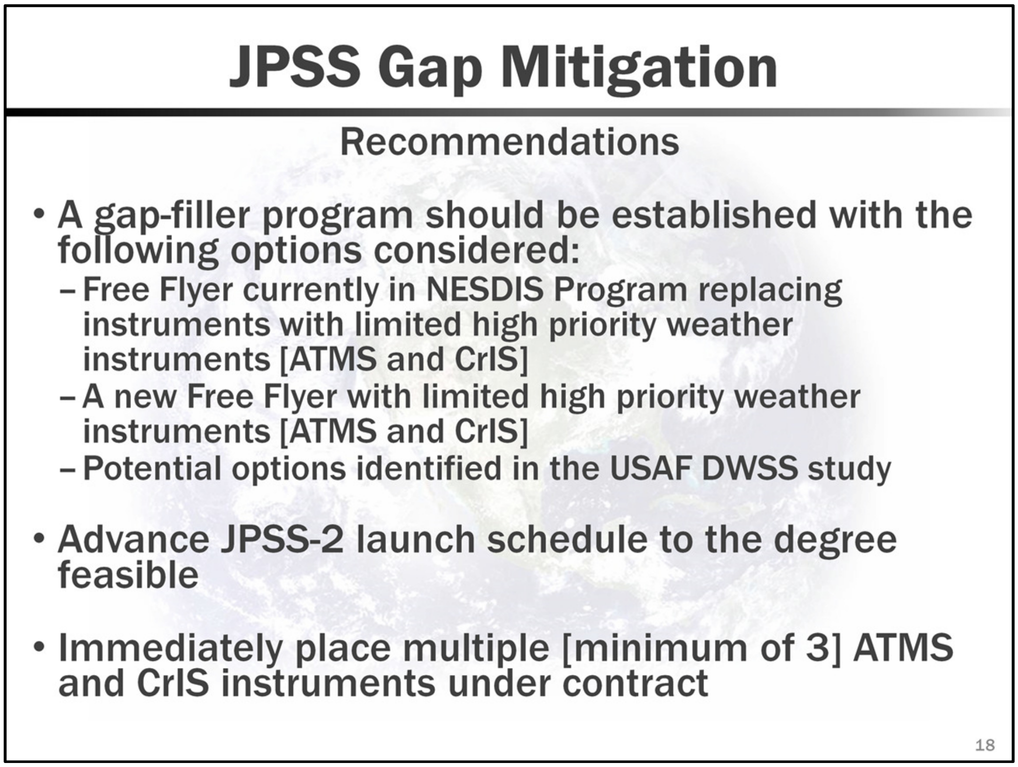
JPSS-2 acceleration identified by the program office is a positive step but this cannot close the potential gap that would occur if there is a launch failure or premature spacecraft failure with JPSS-1.

The later part of the gap occurs because there is no follow-on program to JPSS-2.

While NOAA has taken several actions to implement the recommendations of the “Riverside” Study, they only serve to mitigate the effects of a gap. None of these actions will replace the necessary polar weather data inputs from NOAA polar-orbiting spacecraft.

A gap filler capability is required, but that alone may not mitigate the potential gaps discussed above. However, it is an essential part of closing the gap until the follow-on spacecraft to JPSS-2 are on-orbit and operational.

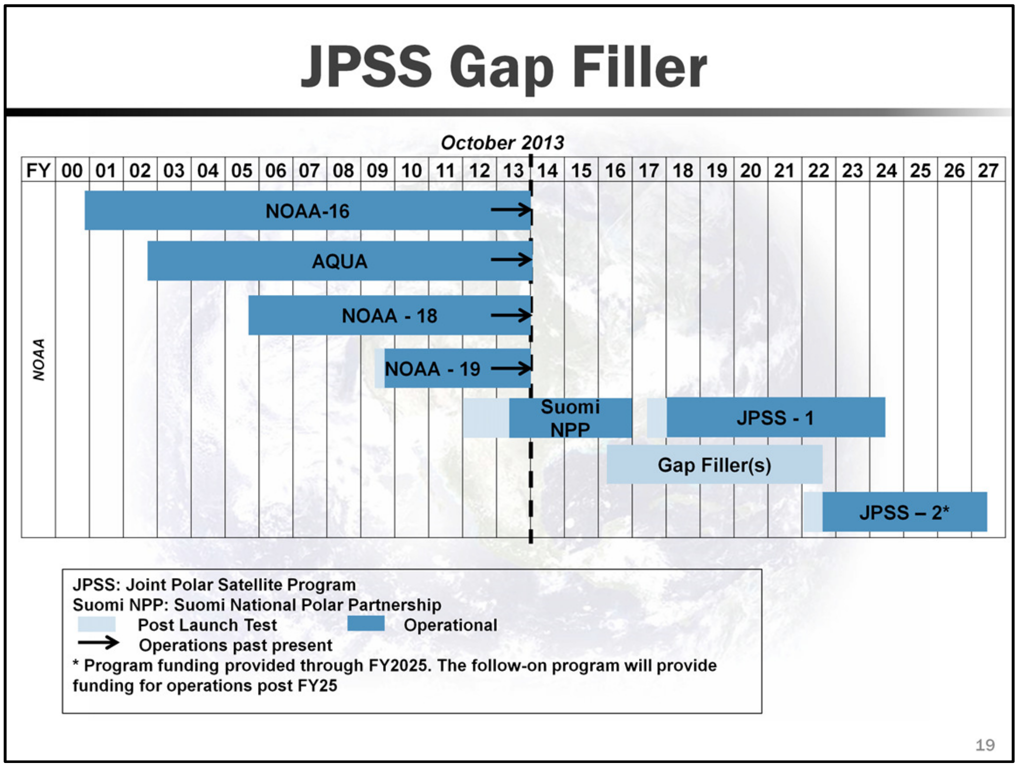
From preliminary analysis, NOAA/NASA estimate that the time necessary to implement a gap filler is 5 years. This would result in a gap of approximately one and one-half years if S-NPP just reaches its nominal mission life and there is no JPSS-1 launch failure or premature spacecraft failure. The gap would be longer if S-NPP fails before its mission design life. The importance of avoiding this potential gap is such that options to shorten the 5 years should be continually examined and the gap filler program should begin immediately.



Since it appears that instruments are the pacing item for a gap filler mission, the fastest way to mitigate gaps would be to place multiple units of the Advanced Technology Microwave Sounder (ATMS) and the Cross-track Infrared Sounder (CrIS) on contract as soon as possible with their current developers. While the JPSS Program is currently reviewing the ATMS and CrIS proposals for JPSS-2 instruments, the IRT strongly recommends that NOAA contract for a minimum of 3 units of each of these instruments immediately. The IRT leaves to NOAA as to whether multiple units of VIIRS (beyond the one for JPSS-2 which is now on contract) and OMPS-Nadir should be added now as well.

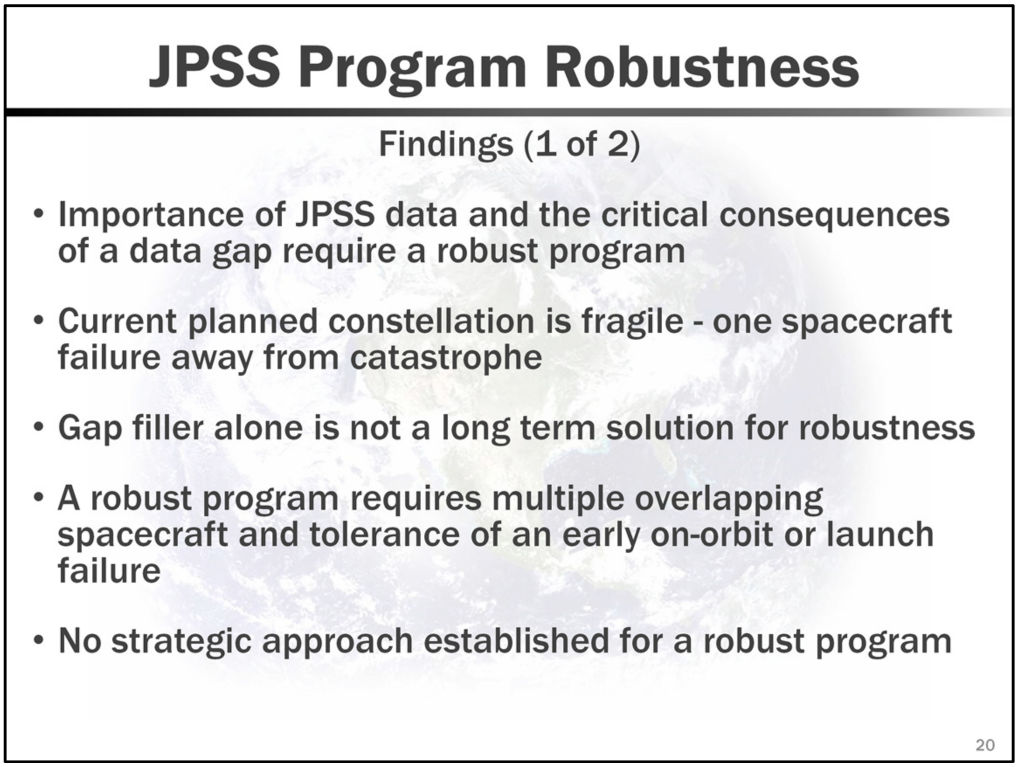
A gap-filler project must be started immediately as a hedge against the early potential gap previously described. As to the feasibility of rapidly developing and deploying spacecraft, there are examples of small Low Earth Orbit (LEO) spacecraft being completed 2-3 years from start. Regarding the instruments, it is recommended that the gap filler fly ATMS and CrIS only. With the right incentives and contract structures, the first of the 3 ATMS and CrIS production instruments could be expected to be available in about 36-42 months after go-ahead. With these cited schedules and with an expedited decision and procurement process, a gap filler mission could protect against a gap before the end of 2017. The subsequent sensors can be ready on 9-12 month centers after the first set, in time for JPSS-2 integration.

In addition, the IRT recommends that NOAA have discussions with the Air Force and others to determine if any other shorter term gap filler options/concepts might be available before 2017, particularly to guard against a premature S-NPP failure.



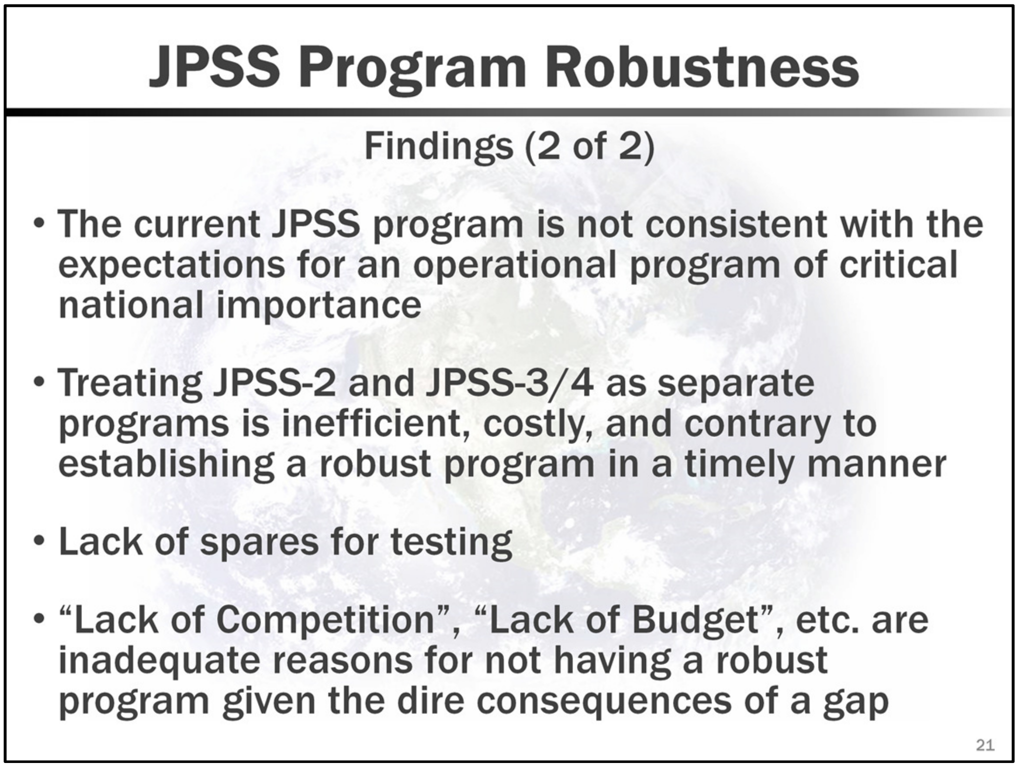
The gap filler bar shown on this chart represents the coverage period necessary to mitigate the most probable gap. The bar should be used to encourage looking at a multitude of solutions that are most responsive to the totality of this bar. The IRT recognizes that the front end part of this bar is most challenging.

Ideally, a gap filler would be available to launch before S-NPP reaches the end of its mission life and would cover a potential gap from a JPSS-1 launch or early spacecraft failure. This plan also moves towards the objective of being two failures away from having no afternoon polar data available.



As for the need for robustness, as discussed earlier, JPSS data are critical to the success of accurate and timely weather and severe storm forecasts. This assessment of the criticality of the JPSS data clearly requires a robust JPSS constellation.

The current JPSS program is fragile. While the IRT believes funding a gap filler is critical it is not a long term solution to the essential need for robustness. A robust program requires multiple overlapping spacecraft developed in a manner that allows downstream components and subsystems to be used as spares for the spacecraft being prepared for launch. As a minimum, the program must be two-failures away from a situation of no afternoon polar data collection capability. The current situation with JPSS as the only approved U.S. polar orbiting program and the fragility of the existing and programmed constellation places the Nation in a very dangerous position. This fragility needs to be corrected immediately.

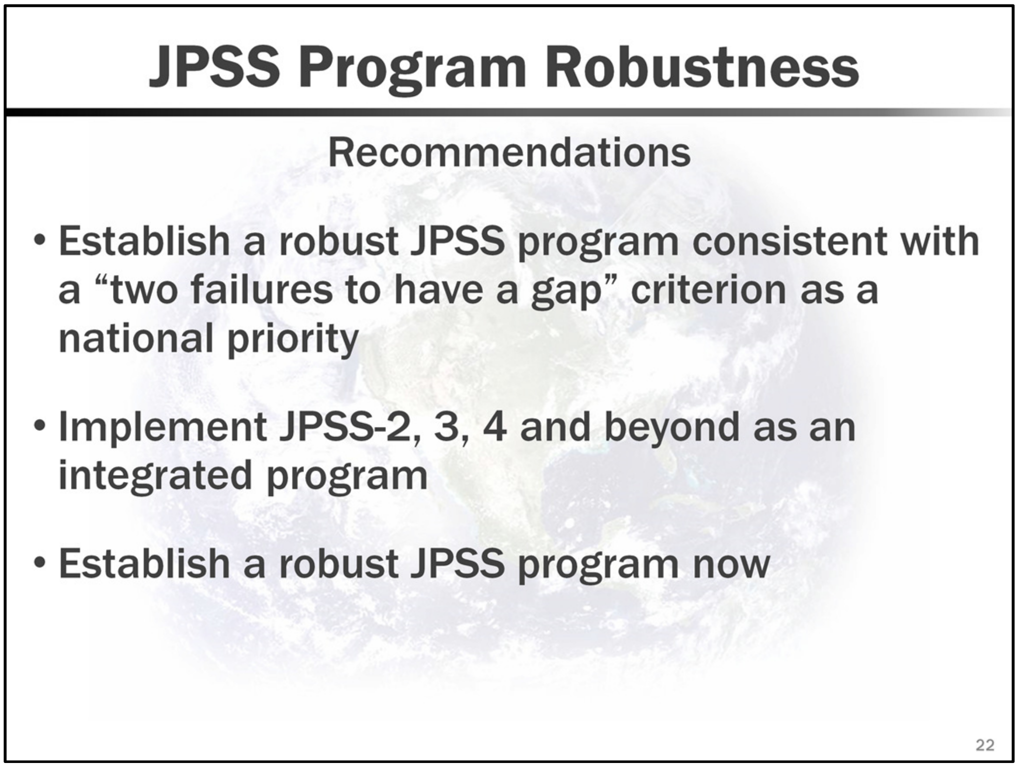


Current procurement strategy for JPSS is one at a time which is inefficient, expensive and not consistent with a robust program.

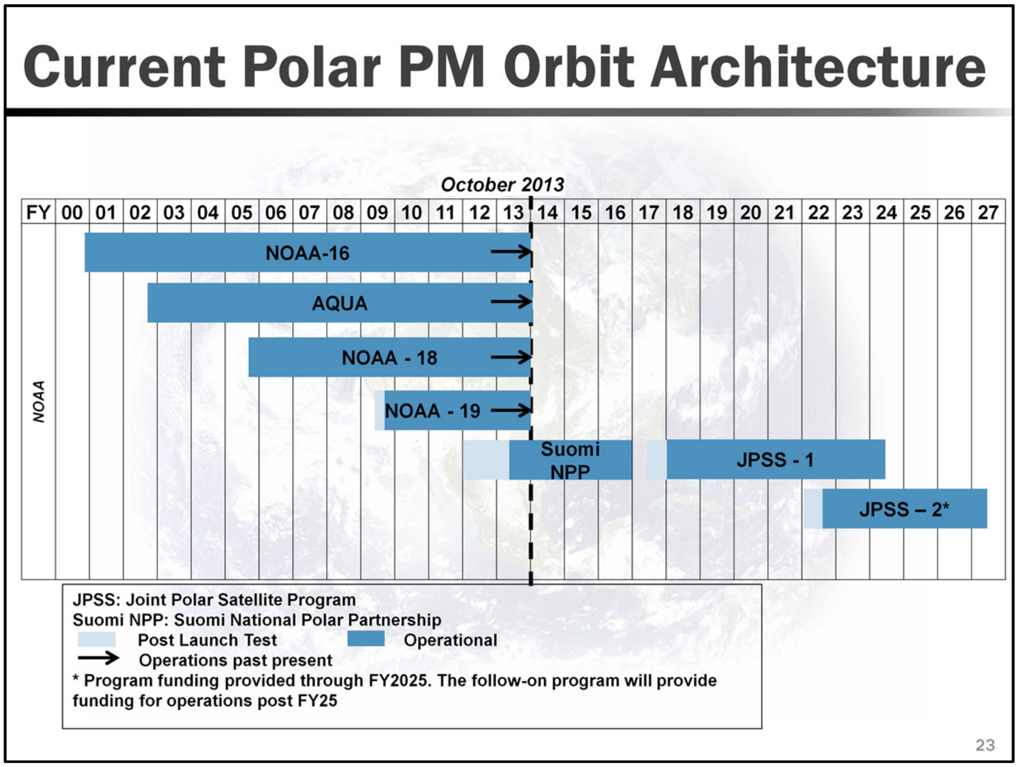
As recommended earlier, procurement of additional ATMS and CrIS must be started immediately. These proven advanced instruments are critical for accurate severe weather warning/prediction.

A procurement for JPSS-2, 3, and 4 as an integrated program should be started now. Other instrument procurements needed should also be initiated to support spacecraft development schedules.

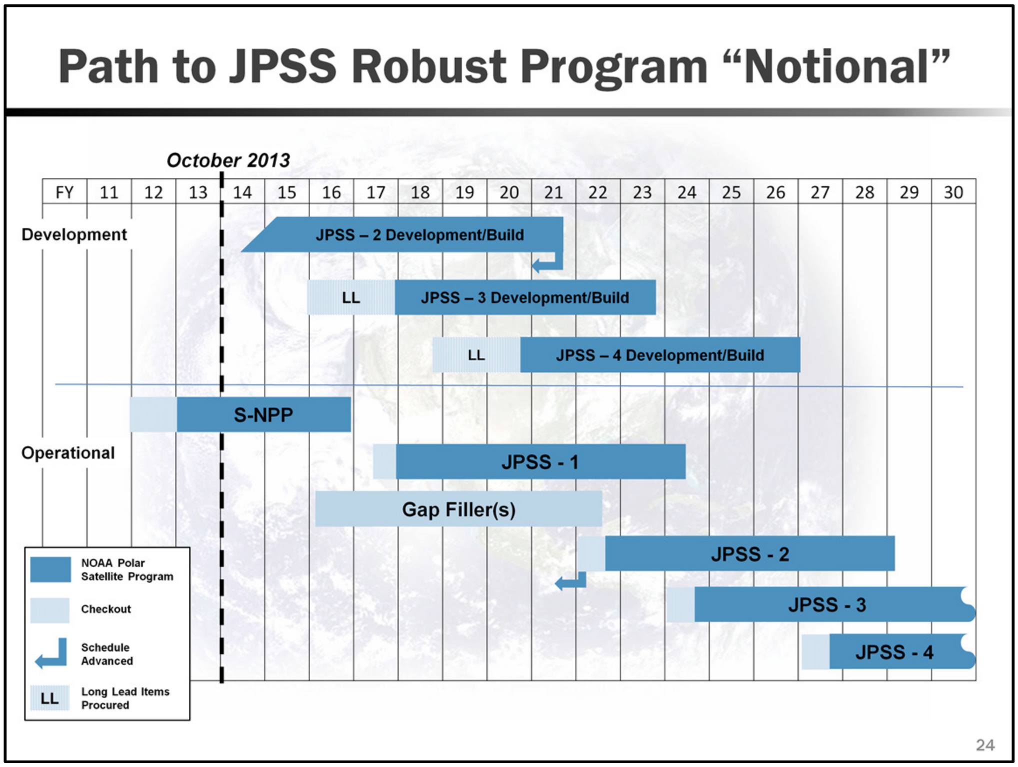
Timing of these acquisitions should be established to ensure the Nation has systems ready to launch in the future so that the JPSS program remains at least two failures away from a gap. This will also resolve the current situation of JPSS having no spare instruments or components available to deal with the uncertainties of factory system tests.



The IRT recommends that NOAA establish a robust JPSS Program, which meets the criteria as described. These recommended actions should be taken now. The team believes these are the minimum actions necessary to build toward a robust operational program.

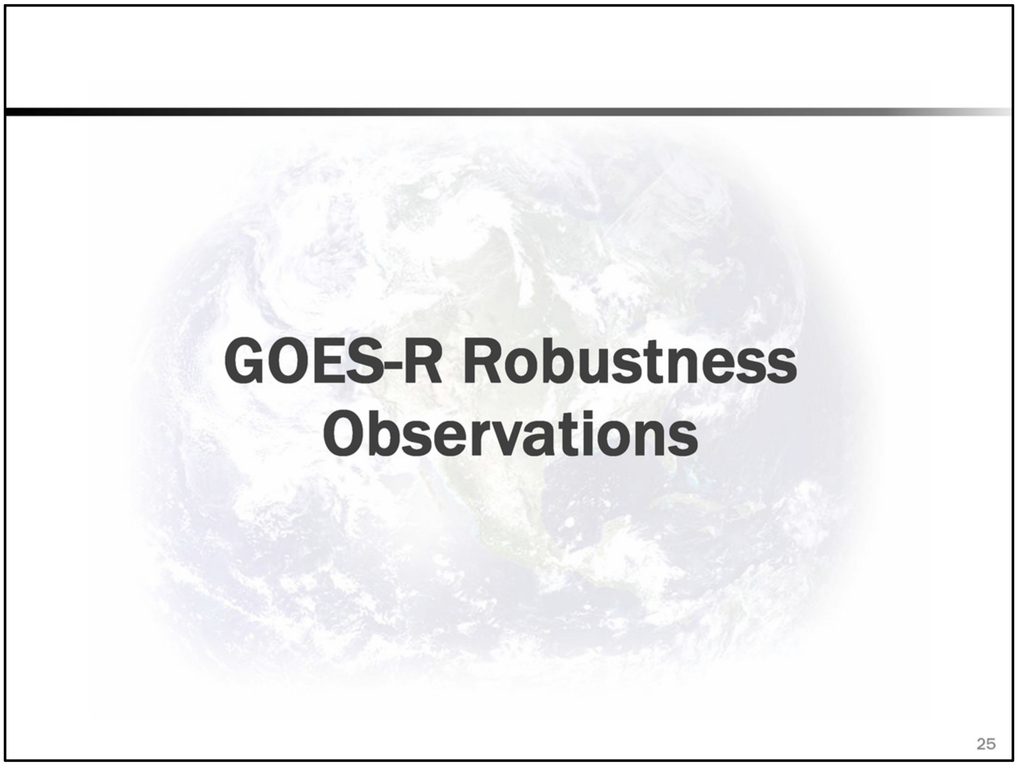


This is a repeat of chart 14 and defines the current polar PM orbit architecture.

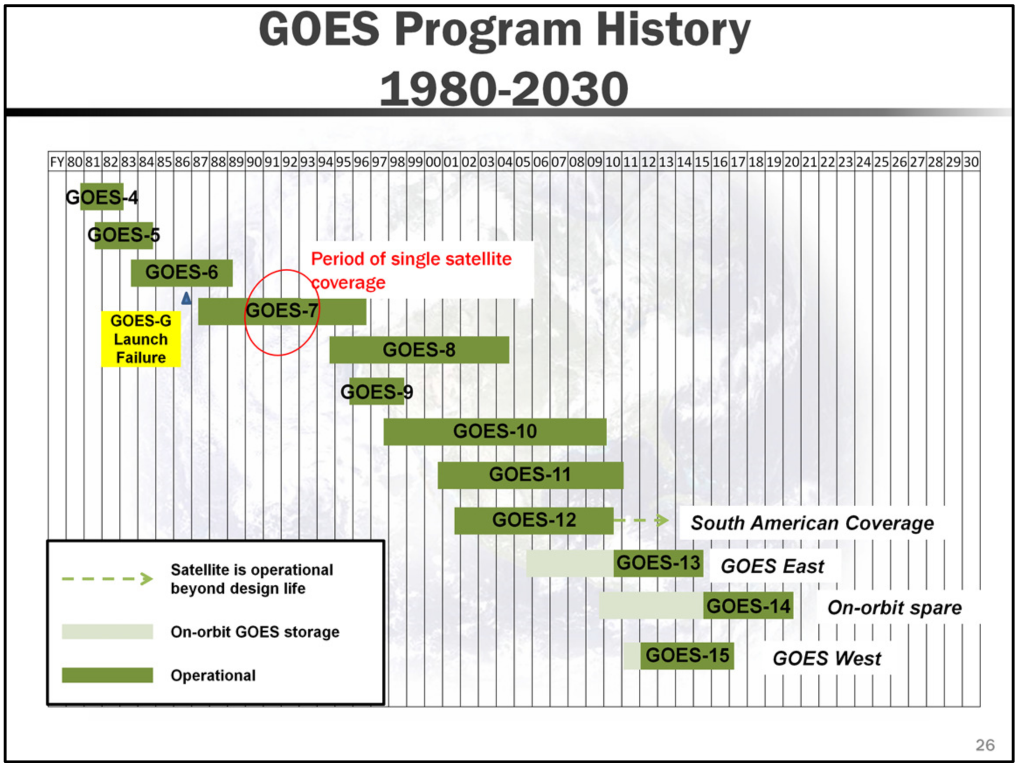


This chart depicts a "Notional" robust JPSS program.   It establishes concurrent development/build of systems to keep factories efficient and to sustain the 2nd-3rd tier suppliers.

This program provides for spacecraft availability for launch so the Nation can remain at least 2 failures away from no afternoon polar data availability.

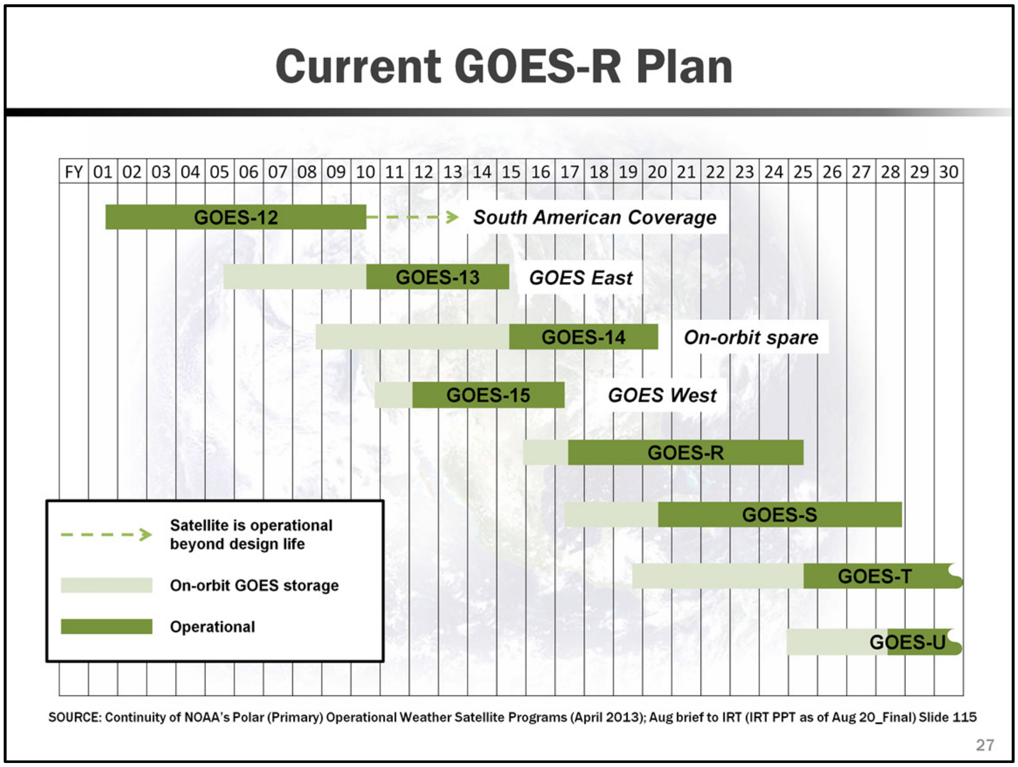


The IRT’s focus has been on JPSS, however, it is important to also consider the robustness of GOES-R.



This chart depicts the historical flow of the civil geostationary orbiting weather satellite system known as the Geostationary Operational Environmental Satellite (GOES) program. The GOES series of satellites provide continuous imagery, atmospheric measurements of Earth's Western Hemisphere and space weather monitoring. It also is the primary tool for the early detection and tracking of hurricanes and severe weather. GOES is nominally a 2 geostationary satellite system, with one satellite monitoring the East Coast out to the coast of Africa where hurricanes form, and the other monitoring the West Coast, Hawaii and Alaska. As a two satellite system, it requires three satellites in order to be two failures from a gap.

As in the case of DMSP and POES, the GOES satellites were built in blocks of satellites where major technology improvements were incorporated periodically via block changes. In this way, several near-identical satellites could be built one after the other in a production line mode. This not only resulted in cost savings, but also created a robust program where the components and sub-systems of downstream satellites became the spares for the satellite getting ready to launch. As can be seen above, this resulted in a reasonably, but not perfectly, robust system in the early years. This is also true with the current program in development. However, this was not the case when the program underwent a block change in the late 1980's resulting in developmental problems. After the GOES-G launch vehicle failure in 1986, and the subsequent end of mission life of GOES-6 in 1989, GOES-7 became the Nation's only geostationary satellite and consequently was moved back and forth between the East and West coasts during their respective storm seasons. Fortunately, an agreement was reached with the Europeans to "borrow" one of their geostationary satellites to help out the U.S., as this single U.S. satellite situation persisted for almost 6 years. This situation was such a major National issue that 6 congressional hearings were held during the summer of 1990 as Congress pressed DOC, NOAA and NASA to understand how this had happened, and to fix the situation as soon as they possibly could. In 1994, GOES-8 was launched, followed shortly thereafter by GOES-9, and the program has been robust ever since. It is this type of gap that the recommendations of this report are aimed at preventing for the current JPSS program.



The GOES program in operation and in development is quite robust. Currently, GOES-13 & 15 are operational with GOES-14 as an on-orbit back-up. GOES-13 has had two temporary outages to date and both times, GOES-14 was activated to provide coverage. The GOES-R series of satellites are planned to continue this robustness. The GOES system today is two failures away from a gap, and thus is robust in the same sense that is recommended for JPSS. Having said that, it is crucial that the funding plan for GOES-R continue to be sustained, so that the Nation never faces a gap in geostationary coverage again.

Additional Areas of Concern

- GOES-R Schedule and Cost
- JPSS Future Program Content
- Why Programs Cost so Much

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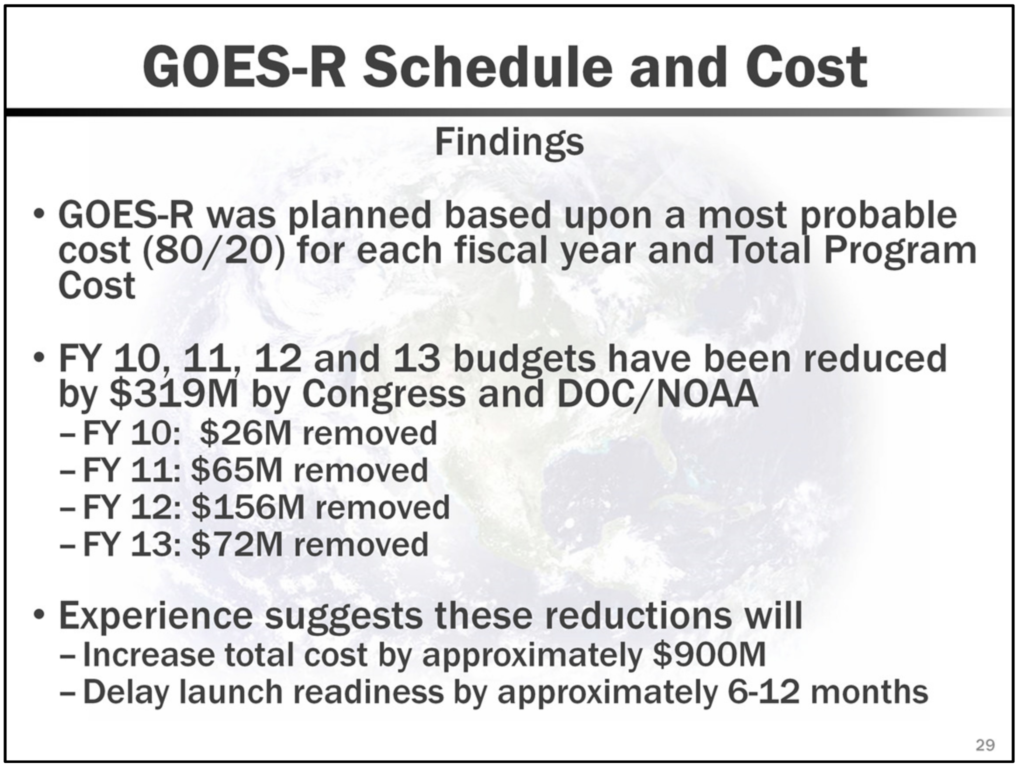
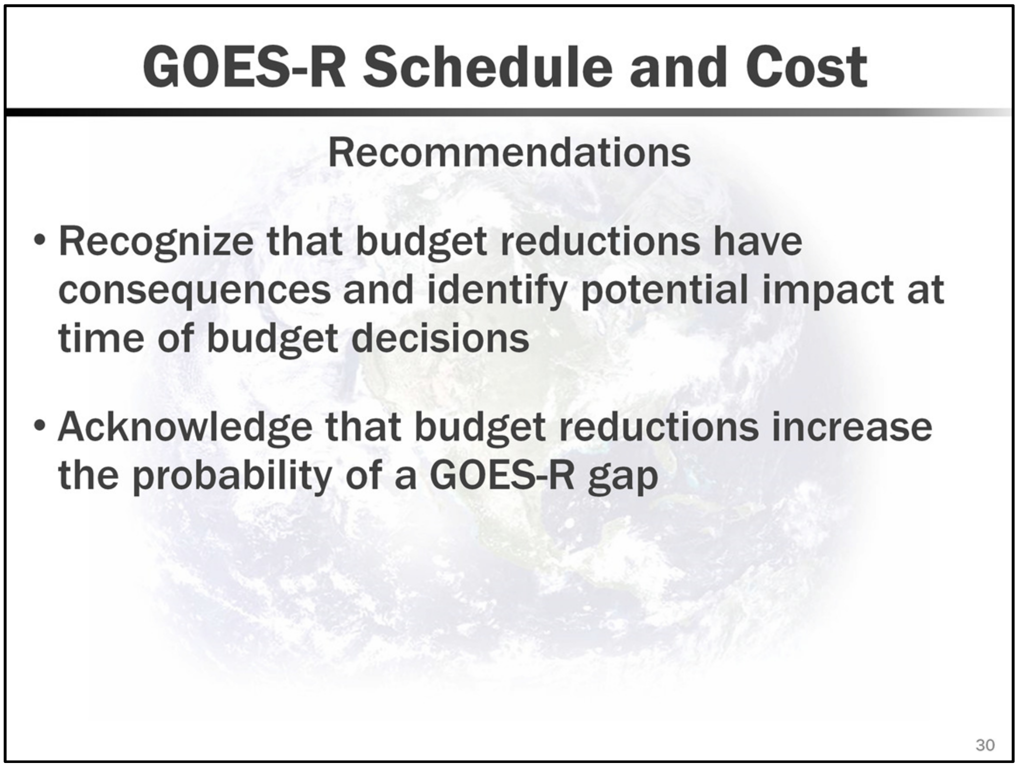
These are three areas of additional concern, which the IRT believes merit discussion.



While the GOES-R program was well planned based upon a most probable cost (80/20) for each fiscal year and for the overall Total Program Cost (see Note below), over the last 4 years, the GOES-R Program has suffered budget cuts. These cuts had a negative impact on the program. For example, advanced data products were descoped, essential GOES-R work was deferred to future years, and delays were imposed on GOES-S because of the need to use its funds on GOES-R. These necessary actions created a likely delay to the GOES-R and GOES-S schedules, and most likely will result in a significant increase in life cycle costs.

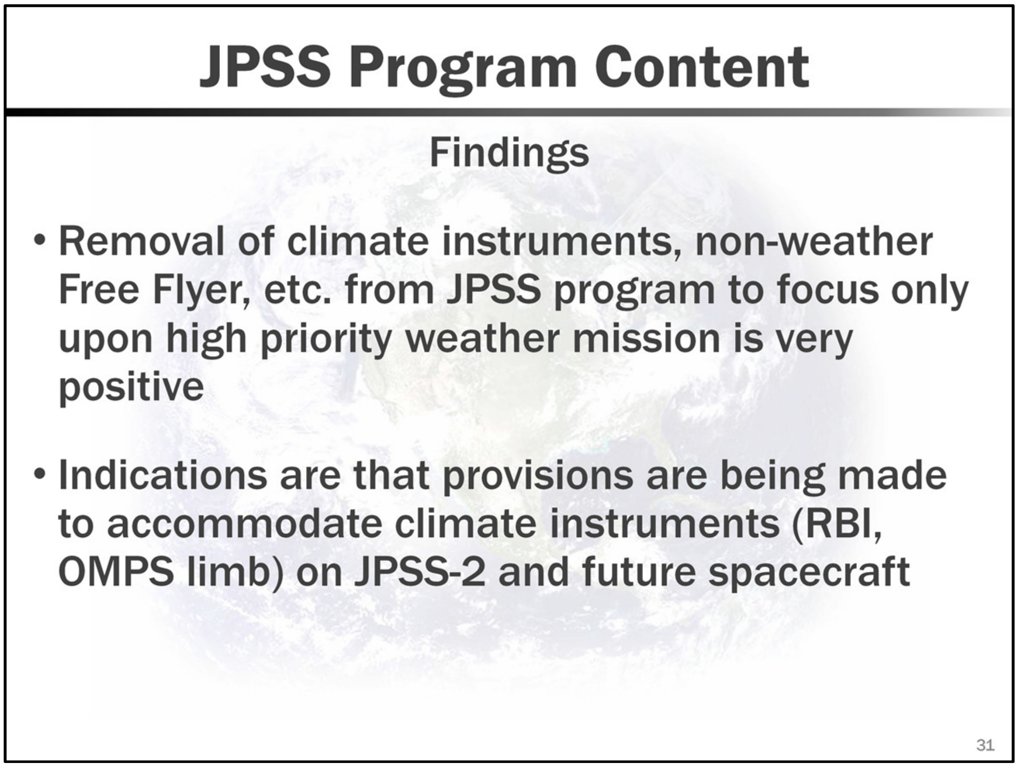
Note: The term Most Probable Cost (80/20) refers to a point on the program cost estimation curve where the actual program cost has an 80 percent chance of being below that point and a 20 percent chance of being above that point, based on program cost estimating data.



While the IRT recognizes the reluctance of program management to delay launch and increase Total Program Cost, the team does not believe that these consequences can be avoided.

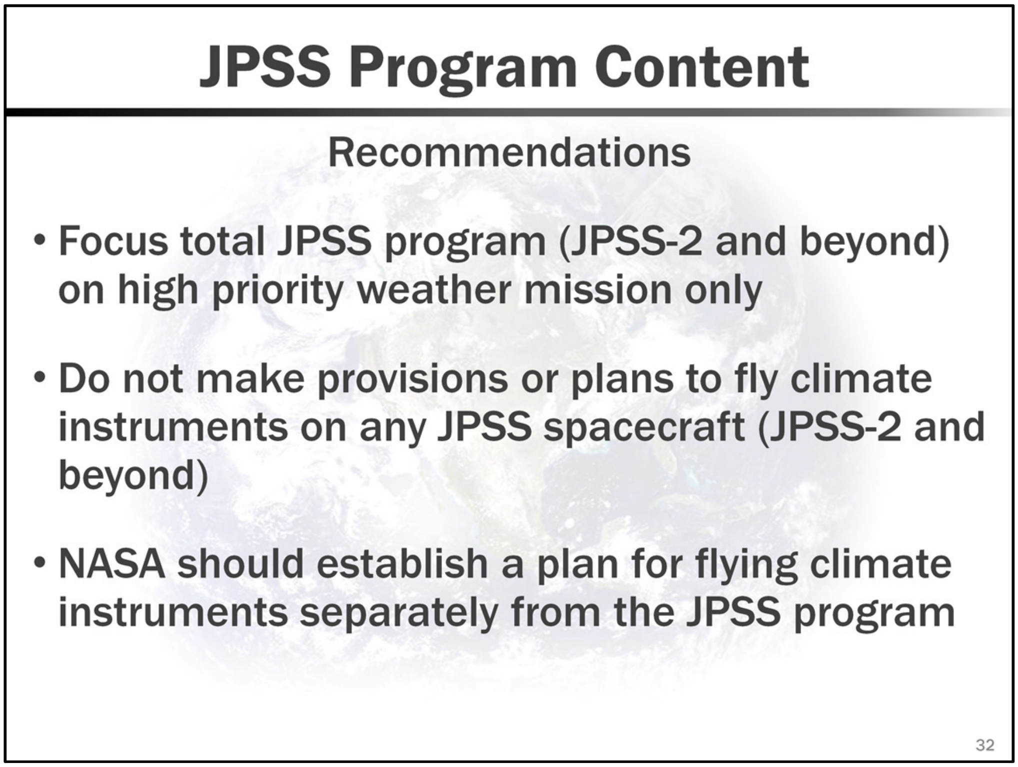
A greater concern is that these past reductions and potential future cuts increase the probability of a gap in geostationary weather observations for the United States. Budget cuts to the program, if continued, could lead to future gaps in the required two satellite coverage.

The IRT believes that the consequences of budget cuts should be acknowledged in the program planning and communicated during the budget review and approval process.

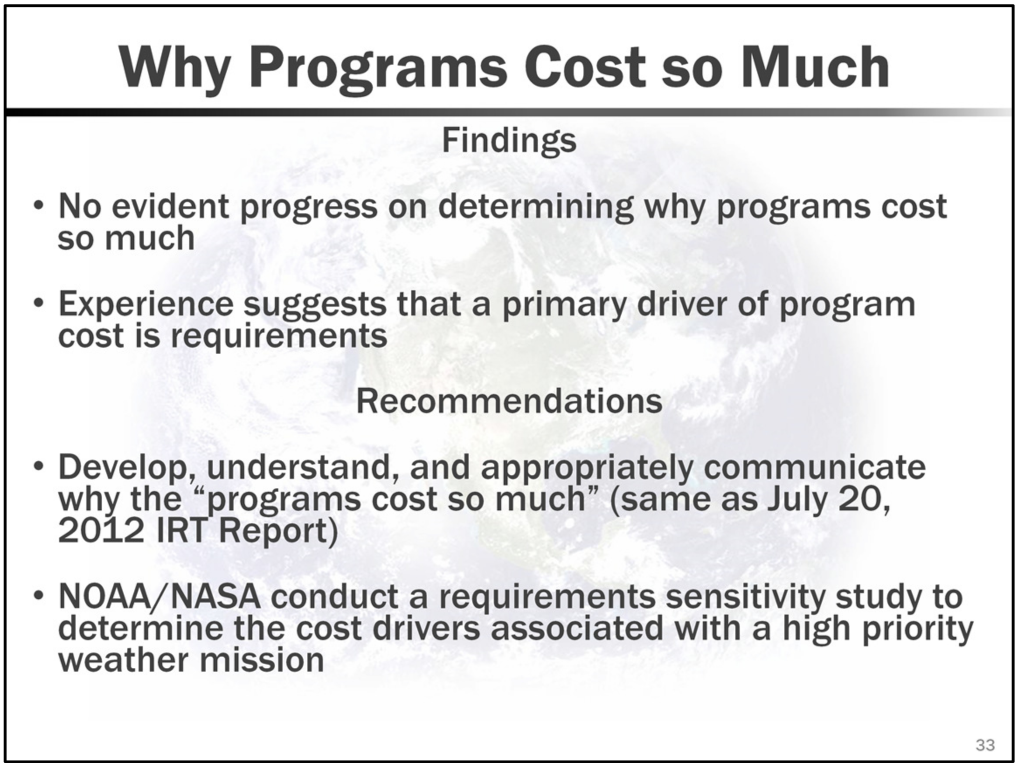


The IRT believes the action to remove the non-weather Free Flyer and the climate instruments from the JPSS program, thereby focusing the JPSS program on the high priority weather mission, is helpful in minimizing the potential of a JPSS gap. The IRT notes that the non-weather free flyer competes for scarce funds in the NOAA/NESDIS budget.

The IRT conviction stated in our 2012 report that the JPSS program should be uniquely focused on high priority weather instruments only [ATMS, CrIS, VIIRS, OMPS-Nadir] remains firm. This conviction is based upon the belief that nothing should compromise the uninterrupted acquisition of critical JPSS weather data. The IRT observes that plans have been developed to fly the removed instruments on JPSS-2 and beyond.



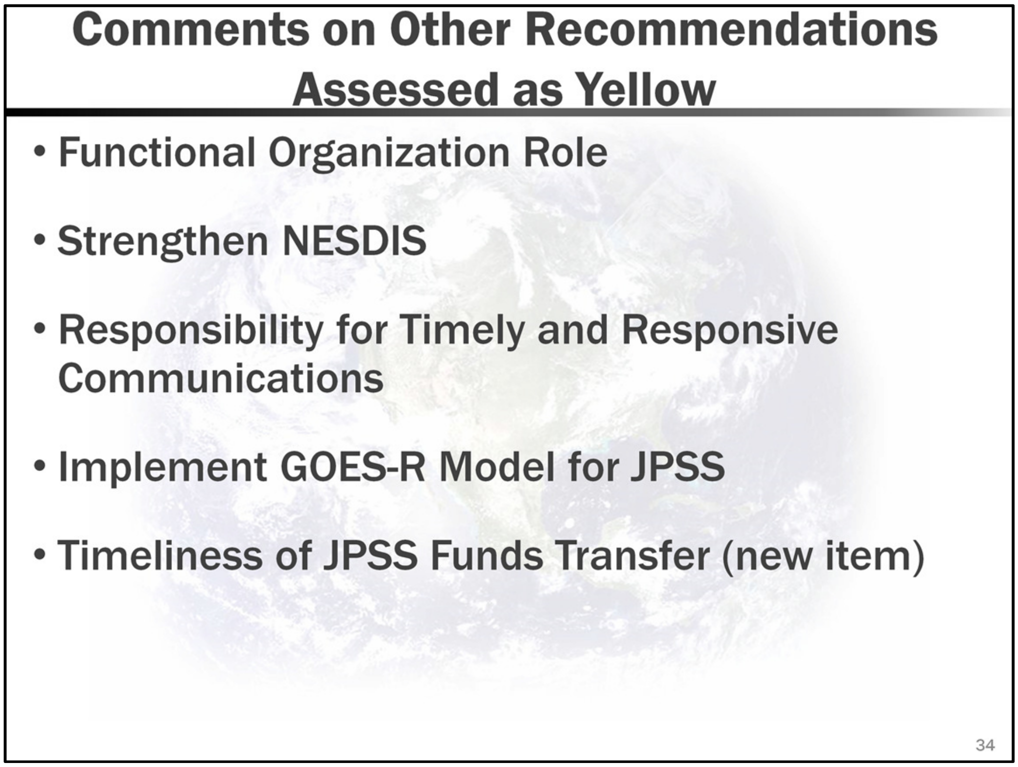
The total JPSS program (JPSS-2 and beyond) should be focused solely on the high priority weather mission. Inclusion of any non-weather elements in the JPSS program, even if supplied by another agency, creates a schedule risk and is therefore unacceptable. Plans and or provisions to fly climate instruments on JPSS-2 and beyond should not be pursued.



In its 2012 report, the IRT noted that the inability to answer the question of "Why the programs cost so much" is an important issue affecting the credibility of the program and NOAA. Additionally, understanding cost factors and drivers could be an important basis for performing cost trades that may be necessary in constrained budget environments. Accordingly, the IRT recommended that a small, ad hoc group be established to determine and communicate the answers to this important question for both JPSS and GOES-R.

Since the 2012 report, an Independent Cost Estimate (ICE) was performed. The IRT was impressed by this work. Perhaps, having the ICE team explicitly expand their study with a specific focus on determining why JPSS and GOES costs so much would be useful.

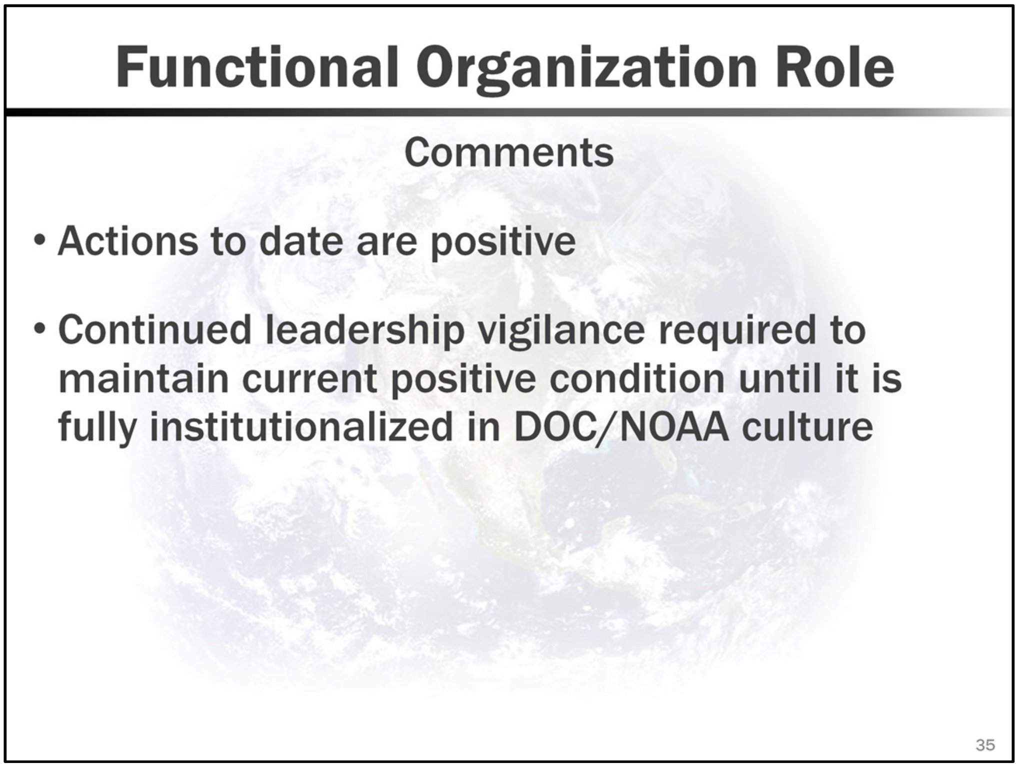
The IRT also continues to think that it would be useful to stand up a group within NOAA/NESDIS/NASA to look at this question. Specific consideration should be given to the following questions: Is the satisfaction of the Key Performance Parameters (KPPs) the primary cost driver? Are there any particular processes or procedures that place extraordinary cost or schedule burden on the program? Are there other drivers such as unusual institutional costs or constraints imposed on the system? Is there a way to articulate the details of the budget that would better demonstrate actual costs going forward and how these costs are allocated?



In the 2012 report, the IRT had serious concerns over the oversight and the decision processes within NOAA and DOC. It found these processes to be dysfunctional and an impediment to successful execution of the GOES-R and JPSS programs. The IRT made six recommendations related to oversight and decision-making. Of these, three (below) have been substantially addressed and the IRT is confident they will be institutionalized, with continued attention from leadership.

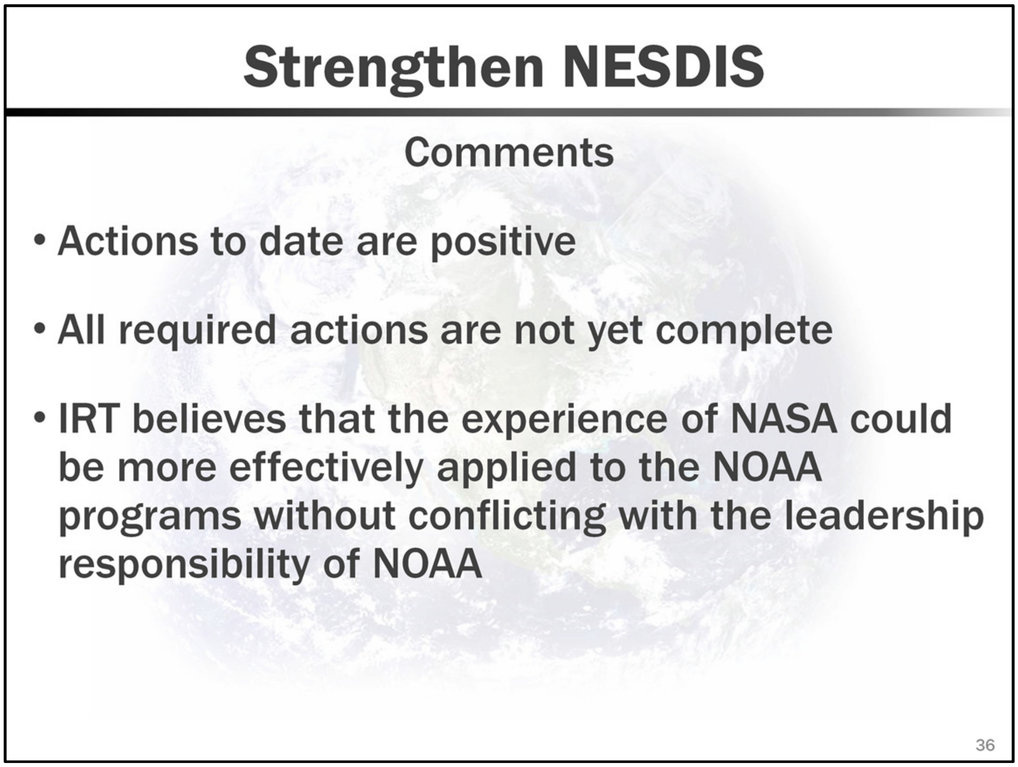
1. A Tiger Team was formed to streamline the DOC/NOAA chain of command oversight; so that it only focused on reviewing the top-level information needed to assess overall program status. The Team reported out with proposed changes that appear to be working well.
2. A Working Group was created to document clearly the characteristics of the key positions associated with the satellite programs and thereby to clarify lines of responsibility, authority and accountability. The Working Group continues to meet and to oversee the culture and business practice changes entailed in implementing the clarified direction.
3. NESDIS was reaffirmed by DOC and NOAA as the primary accountable organization for the execution of NOAA satellite programs, with commensurate authority and responsibility. Continued vigilance is needed to assure that decisions that appropriately belong at the NESDIS level are made there.

The other three recommendations need additional work/focus and are discussed on the next three charts:



In 2012, the IRT found that the DOC and NOAA staff functions, in particular the CFO and the CIO, were too involved in program execution, and that the volume of reporting, review and oversight by the staff offices was excessive and at times adversarial. The IRT acknowledged the necessary role of staff offices in interpreting policy, and the need for checks and balances in program execution, but felt that the exercise of staff functions had become too intrusive and created confusion about responsibility, accountability and authority of senior line managers. The process of staff review also appeared to lose sight of mission and program success as the primary goal of the NESDIS satellite programs.

The actions taken by DOC and NOAA to address this concern have been very positive. These changes are important steps in achieving streamlined oversight and effective execution of programs. However, the goal of balanced, efficient and effective oversight require a culture change within all of the involved organizations. Continued vigilance by the leaders of NOAA and DOC is essential to assure that the positive changes are accepted and institutionalized within the staff organizations, and are resilient to leadership changes.



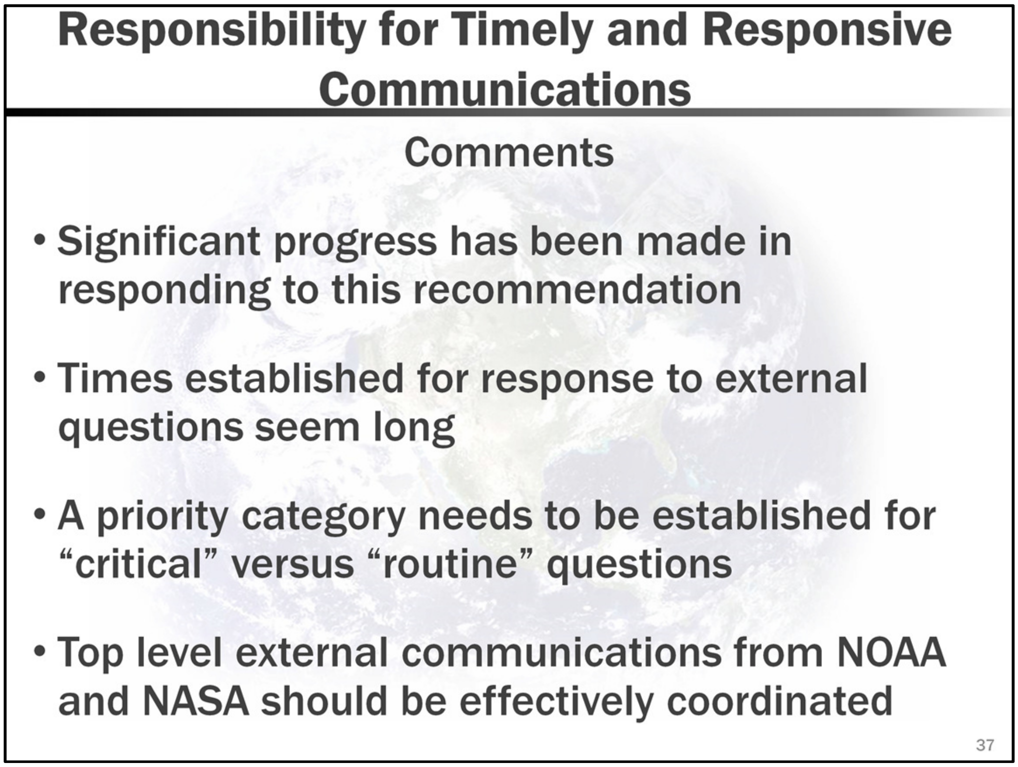
NESDIS, with the support of NOAA and DOC, has made significant strides to strengthen the organizational leadership. In particular, NESDIS has recently hired a permanent Deputy Associate Administrator, Systems (DAAS), and new Directors of Satellite Ground Services and of System Architecture and Advanced Planning are in the process of being hired.

These actions meet the IRT recommendation of hiring at least two to three additional experienced project management professionals.

The IRT believes that a stronger DOC/NOAA and NASA partnership would contribute positively to mission success. In particular, NESDIS should be more aggressive in taking advantage of the NASA/GSFC program management and system engineering capability. Likewise, Goddard needs to be more proactive in assisting NOAA and supporting its programs. Goddard is a partner in the NESDIS satellite enterprise and is invested in its success, yet both NESDIS and Goddard seem to view Goddard as primarily an implementer and not a full-fledged strategic partner. The IRT thinks that Goddard and NESDIS should work together more closely to mature and solidify the partnership within which they are working.

For program management, the IRT urges NESDIS and Goddard to avail themselves of the Goddard senior leadership experience in examining elements such as program cost and schedule to determine whether efficiencies can be realized or alternatives beneficially adopted. On the systems engineering side, Goddard has a deep bench of engineers and could be called on to assist with key activities within NESDIS, including analyses of gap mitigation options, future architecture options and future sensors to meet critical weather forecasting needs.

This partnership concept should also exist between DOC/NOAA leadership and NASA leadership.



A working group composed of senior executives from DOC, NOAA and NESDIS was established to develop and implement a plan for ongoing communications with outside stakeholders. A new quarterly reporting process was implemented with DOC, OMB and Congress. A streamlined process was established and implemented for congressional reports and questions for the record (QFRs). This streamlined process still requires 8 weeks for Congressional reports and 9 weeks for QFRs in response to hearings. *Ad hoc* request schedules are worked individually.

NESDIS has received positive feedback for its new quarterly reporting process with external organizations, and the IRT applauds this step.

The IRT continues to think that the response times for external questions are too long, and that additional effort in this area is required. One suggestion is that some final responses could be handled without additional higher level review.

The IRT also urges DOC/NOAA and NASA to continue to work more closely together in coordinating communications. The IRT has independently observed that DOC/NOAA and NASA do not always say the same thing externally (e.g., to OMB, OSTP, Congress). Any inconsistency in message raises unnecessary questions and concerns.

Implement GOES-R Model for JPSS

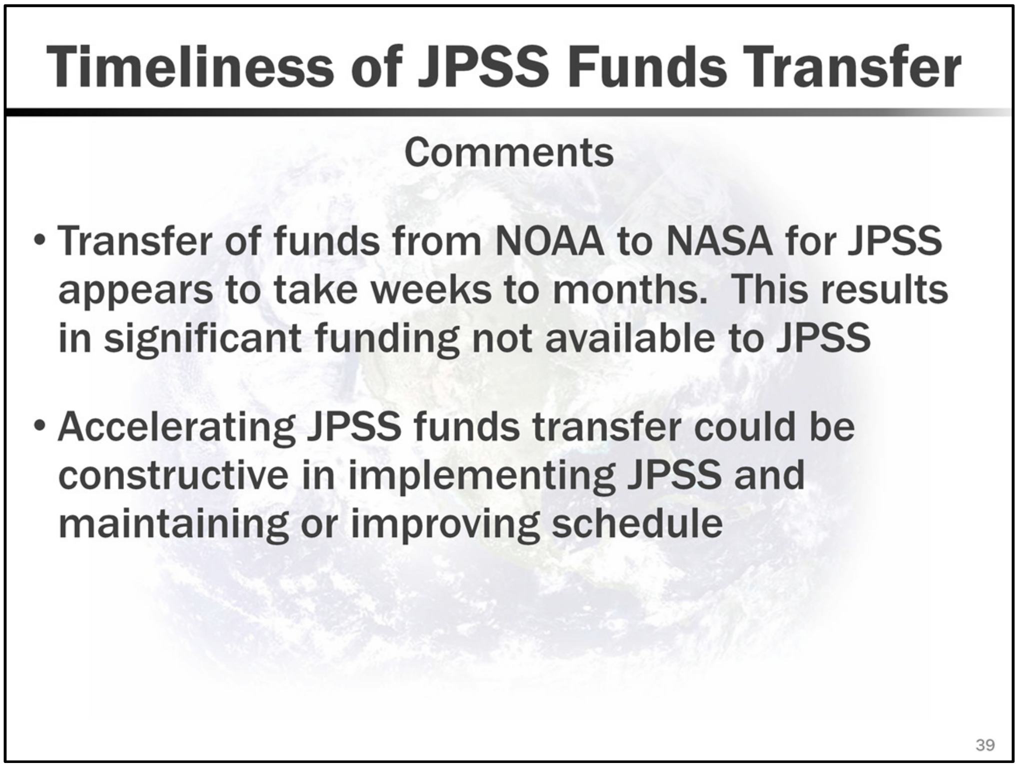
Comments

- Combining NOAA and NASA Systems Engineering functions under NASA leadership is very positive
- IRT continues to believe GOES-R governance model is most efficient and effective model for both GOES-R and JPSS
- Management of GOES-R program appears to be consistent with the above observation
- IRT recognizes NOAA/NASA do not believe changing JPSS to GOES-R model is currently appropriate
- IRT recommends an examination of GOES-R best practices that could be utilized by JPSS. An example may be colocation of JPSS NOAA and NASA leadership

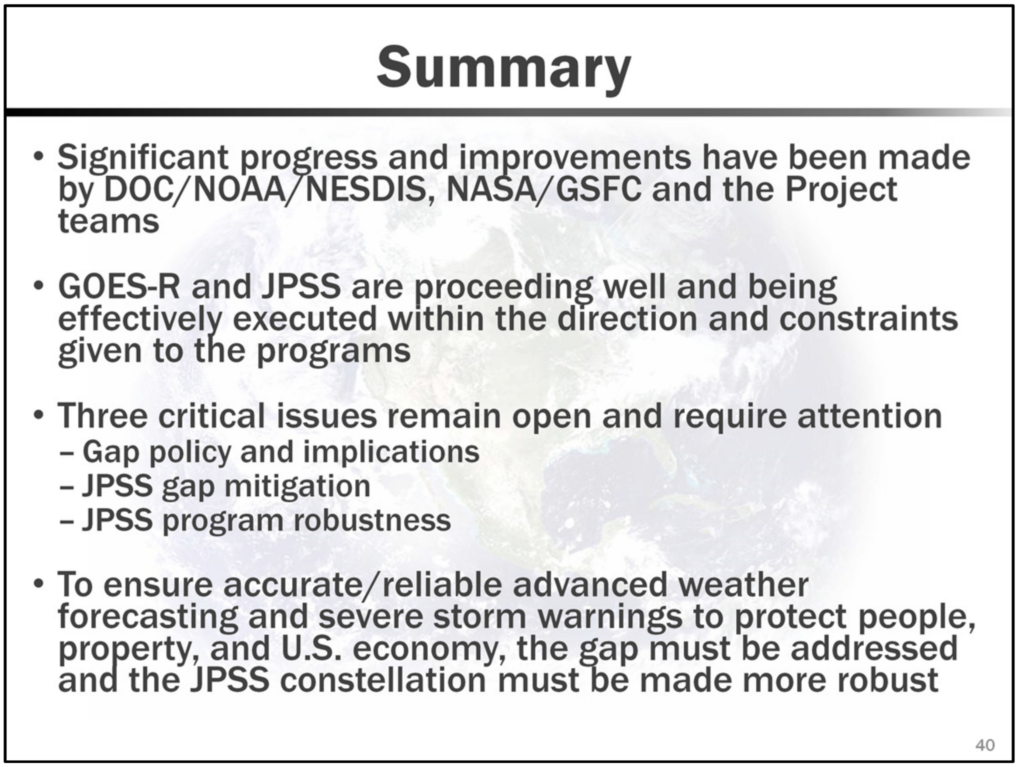
The JPSS program has taken a major step in combining all of its systems engineering functions, formerly split between NASA and NOAA, under the NASA JPSS Program Chief Engineer. This change has brought major improvement to the timeliness and quality of systems engineering work.

The IRT still believes that the GOES-R governance model is more efficient and more effective than that put in place for JPSS. The inefficiency is inherent in several ways including: the construct that has Level 1 direction going from the NOAA JPSS Director through the NASA HQ JASD office to the NASA program (vs. directly); the physical separation of the NOAA JPSS Office from the NASA Program Office; and the fact that there are two program directors, one in NOAA and one in NASA. The IRT remains concerned that the JPSS lines of responsibility, authority and accountability are not as clear as they should be and that the organization is more complex than necessary.

The IRT recognizes that NOAA and NASA believe that the current governance model is appropriate. The IRT accepts that the time to make a significant governance change has probably passed. Nevertheless, NESDIS and GSFC are urged to examine GOES-R best practices to identify those that may be applicable for JPSS. This process should also look for JPSS best practices that are applicable to GOES-R.



The IRT has learned that within the JPSS program, transfer of funds from NOAA to NASA is a very cumbersome process, taking weeks to months. This results in funding being hung-up rather than available to the program, and a need for a significant amount of funds to be carried over to the next fiscal year. This is clearly inefficient for program execution, and the IRT recommends that the process be examined and streamlined for JPSS.



The IRT has completed an assessment of the response to the recommendations documented in the July 20, 2012 IRT report. Five areas of concern were discussed in that report. These concerns were the Oversight and Decision Process, Governance, JPSS Gap, Programs and Budget. While there were recommendations in each area of concern, the “Oversight and Decision Process” and the “JPSS Gap” dominated. The IRT viewed the “Oversight and Decision Process” as so dysfunctional and ineffective that failure to correct the deficiencies would greatly reduce the probability of success of the NOAA satellite program. These issues were largely internal to DOC/NOAA/NESDIS. The current assessment of the IRT is that these issues have been largely resolved.

GOES-R and JPSS are proceeding well and being effectively implemented within the direction and constraints given to the programs.

Critical issues that remain open and require urgent attention are:

- Gap Policy and Implications
- JPSS Gap Mitigation
- JPSS Program Robustness

Without accurate/reliable weather forecasting and severe storm warnings, lives, property and the U.S. economy are at risk. JPSS data are critical to the ability to provide these forecasts and warnings. There is currently an unacceptably high probability of a JPSS gap in observations, and there is not an adequate mitigation plan. The gap must be addressed with a gap mitigation plan and the establishment of a robust JPSS program. The IRT views this as a matter of critical national importance.

The current fragile, non-robust posture of the JPSS program is largely the result of external factors. Numerous decisions have been made that have had an adverse impact on JPSS. Some were decisions with good intentions but negative unintended consequences. The most adverse decision was in response to the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Nunn-McCurdy breach in 2006, which resulted in the elimination of multiple satellites. The proposed NPOESS program to respond to the breach set the stage for the fragile program that exists today. The subsequent decision by the Air Force to eliminate the Defense Weather Satellite System (DWSS) and early funding shortfalls for JPSS-1 further decreased the robustness.

Appendix A

JPSS Summary Rationale

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JPSS Summary Rationale

NOAA's assessment of the need and rationale for JPSS

One of NOAA/NWS's most critical missions is to provide emergency managers with extended (3-7 day) forecasts with the accurate, consistent and high-confidence level they need to make critical decisions that protect American lives and property: ordering effective evacuations, pre-positioning response assets, adequately preparing the public to take appropriate action.

Such forecasts are impossible without robust, high-quality global measurements of the atmosphere required to initialize our numerical weather prediction systems. Polar satellites are the only way to obtain global temperature and moisture measurements and are the backbone of the global observing system.

The JPSS microwave and infrared instruments in afternoon (PM) orbit are critical for ensuring the global satellite coverage required for accurate, extended-range daily weather forecasts, especially for extreme events, with the confidence required to make life-saving decisions.

JPSS is the only viable national satellite program currently in production that can ensure the continuity of these observational data at the quality levels needed to sustain current forecast capability out to and beyond 2017.

Multiple satellite data denial studies have been conducted both nationally and internationally, with the results consistently demonstrating the criticality of polar orbiting satellites, and in particular the value of the afternoon polar orbiting satellites. The studies lead us to the conclusion that a lack of JPSS quality pm polar orbiter data would erode everyday weather forecasts and expose the nation to a 25% chance of missing extreme event forecasts that matter most.

Kathryn Sullivan, Acting Administrator, NOAA
Louis Uccellini, Director, National Weather Service

Appendix B

IRT Members and Support

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IRT Membership

– A. Thomas Young (Chair)
– Dr. Berrien Moore III
– Gen (ret) Thomas S Moorman Jr.
– Dolly Perkins
– Dr. John Schaake
– Lt Gen (ret) Thomas Sheridan
– Dr. Joe M. Straus (JPSS SRB Chair)
– William Townsend (GOES-R SRB Chair)

IRT Secretariat Staff:

– Curt Munechika	Executive Secretary
– Aaron Johnson	Executive Support
– Rebecca Jimenez	Executive Support
– Chris McGowan	Executive Support
– Anne McNamara	Executive Support

IRT Member Biographies

IRT Member	Previous Experience
A. Thomas Young	• President, Martin Marietta Corporation • Director, Goddard Space Flight Center • Chairperson of numerous IRTs for civil and national security sectors
Dr. Berrien Moore III	• VP For Weather & Climate Programs, University of Oklahoma • Executive Director, Climate Central • Director, Institute for the Study of Earth, Oceans and Space, University of New Hampshire
Thomas S. Moorman, General, USAF (Retired)	• Vice Chief of Staff, United States Air Force • Commander, Air Force Space Command • Partner, Booz Allen Hamilton
Dolly Perkins	• Deputy Director, Technical, Goddard Space Flight Center • Director, Flight Projects, Goddard Space Flight Center
Dr. John Schaake	• Deputy Director of the Hydrologic Research Laboratory, NWS • Deputy Director of the Office of Hydrology, NWS • Office of Hydrological Development, NWS
John T. (Tom) Sheridan, Lt General, USAF (Retired)	• Commander, Air Force Space and Missile System Center and AF PEO/Space • Deputy Director, National Reconnaissance Office • VP, National Security Space, the SI Organization
Dr. Joe Straus	• Executive Vice President, Aerospace Corporation • Chair, Space Communications and Navigation Committee, International Astronautical Congress • Standing Review Board Chair, JPSS
William Townsend	• Standing Review Board Chair, GOES-R • VP, Exploration Systems, Ball Aerospace & Technologies Corp. • Deputy Director, Goddard Space Flight Center

Appendix C

Interviews Conducted

Interviews Conducted

Name	Org	Title
Scott Asbury	Ball	JPSS-1 Ball Program Manager
Preston Burch	NASA	NASA JPSS Program Manager
Harry Cikanek	NESDIS	JPSS Director
Orlando Figueroa	NESDIS	Consultant to NESDIS, former Deputy Center Director for Science and Technology, Goddard Space Flight Center
Paula Hartley	Lockheed	GOES-R Lockheed Program Manager
Ellen Herbst	DOC	Assistant Secretary of Commerce for Administration and Chief Financial Officer
Mary Kicza	NESDIS	Assistant Administrator
Greg Mandt	NESDIS	GOES-R System Program Director
George Morrow	NASA	Director, Flight Projects Directorate
Steve Opel	Northrop Grumman	ATMS JPSS Instrument
Mark Poling	Exelis	CrIS JPSS Instrument
Chris Scolese	NASA	Director, Goddard Space Flight Center
Steven Thibault	NESDIS	NESDIS Senior Systems Engineer

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Appendix D

Acronyms

Acronyms

AIRS	Atmospheric Infrared Sounder
AMSU	Advanced Microwave Sounding Unit
AOA	Analysis of Alternatives
ATMS	Advanced Technology Microwave Sounder
AVHRR	Advanced Very High Resolution Radiometer
CFO	Chief Financial Officer
CIO	Chief Information Officer
COSMIC	Constellation Observing System for Meteorology, Ionosphere and Climate
CrIS	Cross-track Infrared Sounder
DAAS	Deputy Associate Administrator, Systems
DMSP	Defense Meteorological Satellite Program
DOC	Department of Commerce
DSCOVR	Deep Space Climate Observatory
DWSS	Defense Weather Satellite System
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
GSFC	Goddard Space Flight Center
GOES	Geostationary Operational Environmental Satellite
GOES-R	Geostationary Operational Environmental Satellite – R Series
ICE	Independent Cost Estimate
IRT	Independent Review Team
ITOS	Integrated Test and Operations System
JCSDA	Joint Center for Satellite Data Assimilation
JPSS	Joint Polar Satellite System
LL	Long Lead
MetOp	Europe's operational polar-orbiting weather satellites dedicated to operational meteorology
MODIS	Moderate Resolution Imaging Spectroradiometer

NASA	National Aeronautics and Space Administration
NASA HQ JASD	NASA Headquarters Joint Agency Satellite Division
NCEP	National Center for Environmental Prediction
NESDIS	National Environmental Satellite, Data, and Information Service
NOAA	National Oceanic and Atmospheric Administration
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NWS	National Weather Service
OMB	Office of Management and Budget
OMPS	Ozone Mapper Profiler Suite
OSTP	Office of Science and Technology Policy
OSVW	Ocean Surface Vector Wind
POES	Polar Operational Environmental Satellites
QFR	Questions for Record
RBI	Radiation Budget Instrument
S-NPP	Suomi-National Polar-orbiting Partnership
SRB	Standing Review Board
TIROS	Television Infrared Observation Satellite Program
USAF	United States Air Force

Appendix E

Figure Sources

Figure Sources

Title Slide Figures
1. Top row starting at left
   1. ABI Prototype Instrument on GOES-R Program
   2. 2010 Washington DC traffic
   3. NOAA Satellite Operations Facility (NSOF)
   4. NOAA's GOES-13 satellite captured this visible image of Hurricane Sandy battering the U.S. East Coast on Monday, Oct 29,
   5. Flooded homes in Tuckerton, NJ on Oct 30 after Hurricane Sandy made landfall on the southern New Jersey coastline on Oct. 29 (U.S. Coast Guard via AFP/Getty Images)
2. Bottom row from left
   1. South Dakota Tornado; Photograph by Carsten Peter, National Geographic; A category F3 tornado (wind speeds between 158 and 206 miles an hour) swirls across a South Dakota prairie.
   2. Concept of GOES-R on-orbit
   3. The Chicago 2011 Blizzard (Feb 02 picture) from 93XRT (CBSLocal)
   4. Storm damage from Sandy over the Atlantic Coast in Mantoloking, New Jersey, on October 31, 2012. (AP Photo/Doug Mills)
   5. NPP after EMI testing

Figure on slide 12: Continuity of Military Weather Satellite Programs 1970-2027
1. Continuity of NOAA's Polar (Primary) Operational Weather Satellite Programs (April 2013); Aug brief to IRT (IRT PPT as of Aug 20_Final) Slide 38
   1. DMSP-19: Launches mid FY2014, Ends mid FY2019
   2. DMSP-17: Planned to end early FY2011 (operations continued until early mid FY2014)
2. DMSG Overview Brief 2
   1. DMSP-15, DMSP-16, & DMSP-19 are in Mid-Morning Orbit
   2. DMSP-13, DMSP-14, & DMSP-17 are in Early Morning Orbit
3. A HISTORY OF THE MILITARY POLAR ORBITING METEOROLOGICAL SATELLITE PROGRAM; R. Cargill Hall; September 2001; OFFICE OF THE HISTORIAN / NATIONAL RECONNAISSANCE OFFICE
   1. DMSP 5A 1 Launched Feb-70 End of Mission Date (EMD) Mar-71
   2. DMSP 5A 2 Launched Sep-70 EMD Feb-71
   3. DMSP 5A 3 Launched Feb-71 EMD Mar-73
   4. DMSP 5B 1 Launched Oct-71 EMD Apr-72
   5. DMSP 5B 2 Launched Mar-72 EMD Feb-74
   6. DMSP 5B 3 Launched Nov-72 EMD May-75
   7. DMSP 5B 4 Launched Aug-73 EMD Jan-77
   8. DMSP 5B 5 Launched Mar-74 EMD May-76
   9. DMSP 5C 1 Launched Aug-74 EMD Dec-77
   10. DMSP 5C 2 Launched May-75 EMD Nov-77
   11. DMSP 5C 3 Launched Feb-76 Failed to Orbit; Improper fuel loading
   12. DMSP F-1 Launched Sep-76 EMD Sep-79
   13. DMSP F-2 Launched Jun-77 EMD Mar-80
   14. DMSP F-3 Launched May-78 EMD Feb-84
   15. DMSP F-4 Launched Jun-79 EMD Aug-80
   16. DMSP F-5 Launched Jul-80 Failed to Orbit; 4th Stage Failure
   17. DMSP F-6 Launched Dec-82 EMD Aug-87
   18. DMSP F-7 Launched Nov-83 EMD Oct-87
   19. DMSP F-8 Launched Jun-87 EMD Aug-91
   20. DMSP F-9 Launched Feb-88 EMD Feb-92
   21. DMSP F-10 Launched Dec-90 EMD Feb-95
   22. DMSP F-11 Launched Nov-91 EMD Aug-00
   23. DMSP F-12 Launched Aug-94 EMD Apr-97
4. European Space Agency Handbook
   1. DMSP F-13, 1997 - 2008, NOAA
   2. DMSP F-14, 1997 - 2013, NOAA / USAF
   3. DMSP F-15, 1999 - 2013, NOAA / USAF
   4. DMSP F-16, 2003 - 2013, NOAA / USAF
   5. DMSP F-17, 2006 - 2013, NOAA / USAF
   6. DMSP F-18, 2009 - 2014, NOAA / USAF

Figure on slide 13: Continuity of Civil Polar Weather Satellite Programs 1970-2027
1. Continuity of NOAA's Polar (Primary) Operational Weather Satellite Programs (April 2013); Aug brief to IRT (IRT PPT as of Aug 20_Final) Slide 38
   1. NOAA-19: Launched mid FY2009, Ends early FY2013 (operations continue)
   2. S-NPP: Launched early FY2012, Ends end of FY2016
   3. JPSS-1: Launches mid FY2017, Ends mid FY2024
   4. JPSS-2: Launches early FY2022, Ends mid FY2027
   5. MetOp-A: Planned to end early FY2014 (planned to continue until early FY2019)
   6. MetOp-B: Launched end FY2011, Ends mid FY2018
   7. MetOp-C: Launches end FY2017, Ends end of FY2022
2. NOAA-13 Failure Report, August 1994
   1. NOAA-13 Launched August 9th, CY1993; Failure August 21st, CY1993
3. GSFC NSSDC Catalog Website
   1. NOAA-13 was intended for the afternoon orbit
4. NOAA STAR Website
   1. NOAA 14: Launched Dec CY1994 into afternoon orbit
5. eoPortal Directory Website
   1. NOAA-15 morning orbit; Launched May CY1998
   2. NOAA-16 afternoon orbit; Launched Sept. CY2000
   3. NOAA-17 morning orbit; Launched June CY2002, end April CY2013
   4. NOAA-18 afternoon orbit; Launched May CY2005
   5. NOAA-19 afternoon orbit
6. OSO NOAA Website
   1. NOAA-18 and NOAA-16 are secondary satellites in PM orbit
7. NOAA satellite history UPDATE to FINAL 05132011v1
   1. ITOS-1: Launched Jan CY1970*; Ending June CY1971*
   2. NOAA-1: Launched Dec. CY1970*; Ending Jan. CY1971*
   3. ITOS-B: Launch Failure *Oct CY1971*
   4. NOAA-2: Launched Oct. CY1972*; Ending Jan. CY1975*
   5. ITOS-E: Launch Failure *July CY1973*
   6. NOAA-3: Launched Nov. CY1973*; Ending Aug. CY1976*
   7. NOAA-4: Launched Nov. CY1974*; Ending Nov. CY1978*
   8. NOAA-5: Launched July CY1976*; Ending July CY1979*
   9. TIROS-N: Launched Oct. CY1978; Ending Nov. CY1980
   10. NOAA-6: Launched June CY1979; Ending Sept. CY1983
   11. NOAA-B: Launch Failure May CY1980
   12. NOAA-7: Launched June CY1981; Ending Feb. CY1985
   13. NOAA-8: Launched Mar. CY1983; Ending May CY1984
   14. NOAA-9: Launched Dec. CY1984; Ending Feb.CY1998
   15. NOAA-10: Launched Sept. CY1986; Ending Sept. CY1991
   16. NOAA-11: Launched Sept CY1988; Ending June CY2004
   17. NOAA-12: Launched May CY1991; Ending Aug. CY2007
8. Aqua NASA Website
   1. Aqua was launched in May CY2002; design life is 6 years; currently operating with no issues; website states: "strong chance of operating successfully into the early 2020s"
9. Future of NPOESS : results of the NunnMcCurdy review of NOAA's weather satellite program

Figures on slides 14: Current U.S. Polar Orbit Plan, 19: JPSS Gap Filler, 23: Robustness of JPSS Architecture and 24: Path to JPSS Robust Program "Notional"
1. Continuity of NOAA's Polar (Primary) Operational Weather Satellite Programs (April 2013); Aug brief to IRT (IRT PPT as of Aug 20_Final) Slide 38
   1. NOAA-19: Launched mid FY2009, Ends early FY2013 (operations continue)
   2. S-NPP: Launched early FY2012, Ends end of FY2016
   3. JPSS-1: Launches mid FY2017, Ends mid FY2024
   4. JPSS-2: Launches early FY2022, Ends mid FY2027
2. eoPortal Directory Website
   1. NOAA-16 afternoon orbit; Launched Sept. CY2000
   2. NOAA-18 afternoon orbit; Launched May CY2005
   3. NOAA-19 afternoon orbit
3. OSO NOAA Website
   1. NOAA-18 and NOAA-16 are secondary satellites in PM orbit
4. Aqua NASA Website
   1. Aqua was launched in May CY2002; design life is 6 years; currently operating with no issues; website states: "strong chance of operating successfully into the early 2020s"

Figure on slide 26: GOES Program History 1980-2030
1. Continuity of GOES Operational Satellite Programs (April 2013); Aug brief to IRT (IRT PPT as of Aug 20_Final) Slide 115
   1. GOES-12: Planned end of life mid FY2010, Operations beyond life (South American overage)
   2. GOES-13: Planned operations mid FY2010 to mid FY2015 (GOES East)
   3. GOES-14: Launched end FY2009, Operations mid FY2015 ending mid FY2020 (On-Orbit Spare)
   4. GOES-15: Launched end FY2010, Operation early FY2012 ending early FY2017 (GOES West)
2. History of NOAA Satellite Programs--Updated October 2009
   1. GOES-4: Launched Sept CY1980, End Nov CY1982
   2. GOES-5: Launched May CY1981, End Jul CY1984
   3. GOES-6: Launched Apr CY1983, End Jan CY1989
   4. GOES-G: Launch Failure May CY1986
   5. GOES-7: Launched Feb CY1987, End Jun CY1996
   6. GOES-8: Launched Apr CY1994, End May CY2004
   7. GOES-9: Launched May CY1995, End Jul CY1998
   8. GOES-10: Launched Apr CY1997, End Dec CY2009
   9. GOES-11: Launched May CY2000
   10. GOES-12: Launched July CY2001
   11. GOES-13: Launched May CY2006
   12. GOES-14: Launched June CY2009
3. OSO NOAA Webpage
   1. GOES-11: Launched May CY2000, End Dec CY2011

Figure on slide 27: Current GOES-R Plan
1. Continuity of GOES Operational Satellite Programs (April 2013); Aug brief to IRT (IRT PPT as of Aug 20_Final) Slide 115
   1. GOES-12: Planned end of life mid FY2010, Operations beyond life (South American overage)
   2. GOES-13: Planned operations mid FY2010 to mid FY2015 (GOES East)
   3. GOES-14: Launched end FY2009, Operations mid FY2015 ending mid FY2020 (On-Orbit Spare)
   4. GOES-15: Launched end FY2010, Operation early FY2012 ending early FY2017 (GOES West)
   5. GOES-R: Planned launch end FY2015, Operations from mid FY2017 to mid FY2025
   6. GOES-S: Planned launch mid FY2017, Operations from mid FY2020 to end FY2028
   7. GOES-T: Planned launch mid FY2019, Operations from mid FY2025 to end FY2033
   8. GOES-U: Planned launch early FY 2025, Operations from mid FY2028 to past end FY2036
2. History of NOAA Satellite Programs--Updated October 2009
   1. GOES-12: Launched July CY2001
   2. GOES-13: Launched May CY2006
   3. GOES-14: Launched June CY2009